EXHIBIT G

GEOSYSTEMS
ENGINEERING, INC.

GEOTECHNICAL ASSESSMENT REPORT

CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE
SLOPE FAILURE
CUMMING, FORSYTH COUNTY, GEORGIA

Prepared for:

CITY OF CUMMING, GEORGIA
C/0 CIVIL ENGINEERING CONSULTANTS, INC.
4994 LOWER ROSWELL ROAD, SUITE 18
MARIETTA, GEORGIA 30068

GeoSystems Project No. 22-2875
April 5, 2023

GEOSYSTEMS
ENGINEERING, INC.

April 5, 2023

City of Cumming, Georgia
c/o Mr. Gil Puffer, P.E.
Civil Engineering Consultants, Inc.
4994 Lower Roswell Road, Suite 17
Marietta, Georgia 30068

Re: Geotechnical Assessment Report
City of Cumming
Highway 20 Sawnee Tank Site - Slope Failure
Cumming, Forsyth County, Georgia
GeoSystems Project No. 22-2875

Dear Mr. Puffer:

GeoSystems Engineering, Inc. (GeoSystems) is pleased to submit the results of our geotechnical assessment and repair recommendations for the December 2022 massive slope failure at the existing Sawnee tank site located at 921 Canton Highway (Georgia Highway 20), Cumming, Georgia. The following report includes the results of our site history research, field explorations, laboratory testing and stability analysis.

Thank you for the opportunity to provide these services and we look forward to continuing working with you on the slope repairs at the site. Please feel free to call us should you have any questions or require additional information.

Sincerely,

GeoSystems Engineering, Inc.

Larry D. Mullins, P.E.
Senior Registered Engineer

GEORGIA
REGISTERED
No. 11279
PROFESSIONAL
04/05/2023
ENGINEER
LARRY D. MULLINS

11285 Elkins Road, Suite F2 • Roswell, Georgia 30076 • (678) 722-0340

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INTRODUCTION

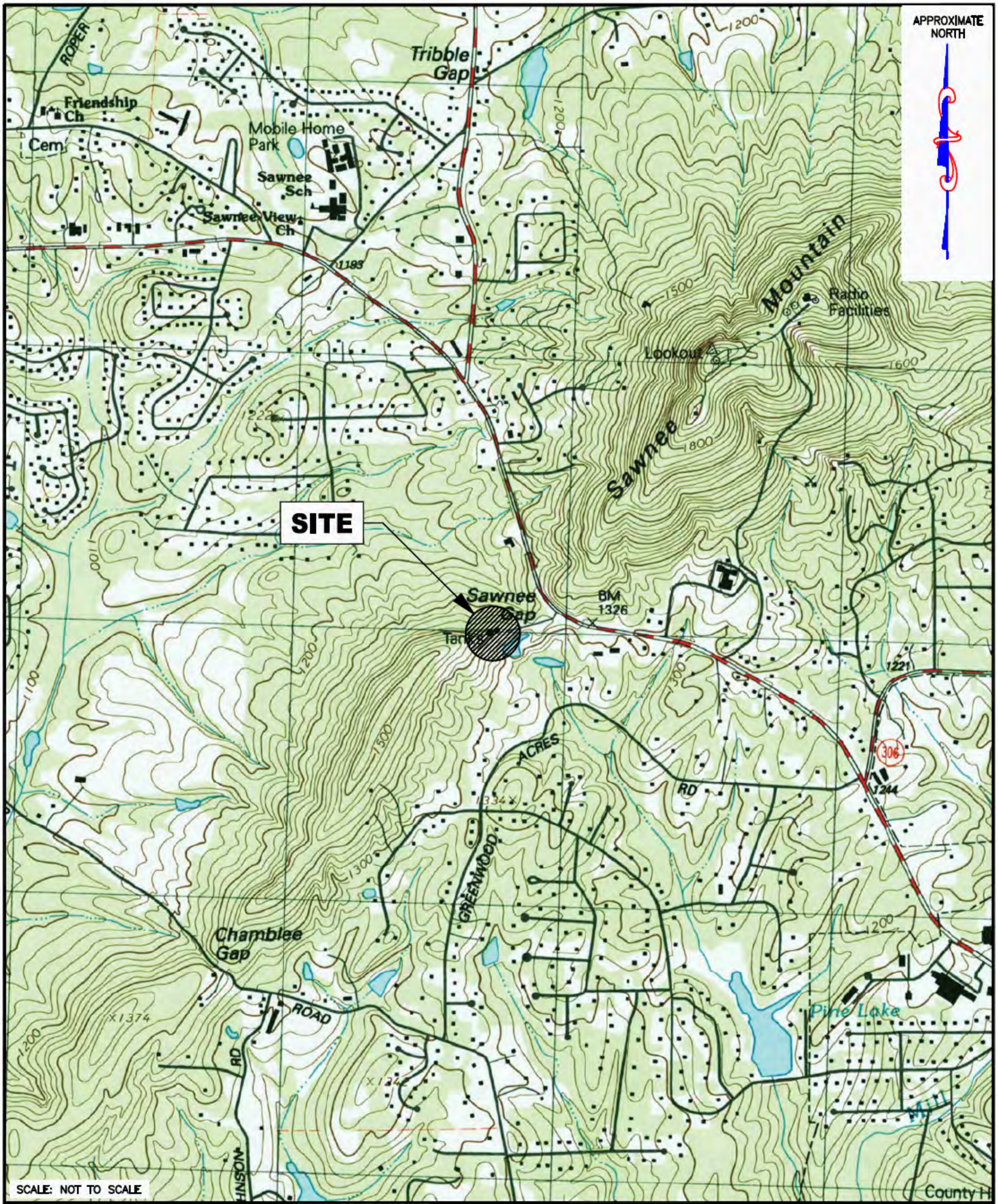
GeoSystems Engineering, Inc. (GeoSystems) was retained by the City of Cumming (City) in December 2022 to provide an initial assessment of a massive slope failure at the existing Sawnee tank site located at 921 Canton Highway (Georgia Highway 20), Cumming, Georgia. The failure emptied both water tanks at the site and impacted the adjacent property at 911 Canton Highway along the southeast side of the tank site. The adjacent property is currently owned by Blount Construction, Inc. The "site" referenced in this report collectively refers to the Sawnee tank site and the adjacent 911 Canton Highway property study area. Figure 1 - Site Map shows the approximate location of the site on the 1999 USGS topographic map of the area. Subsequent geotechnical exploration, laboratory soil testing, geophysical investigation and slope stability analyses were performed by GeoSystems to assess long-term slope stability at the site and provide permanent repair recommendations for the failed slope.

The December 2022 failure of the existing slope, located near the southeast corner of the tank site, reportedly occurred sometime during the night of December 6, 2022. The failure scarp impacted the entire southeastern hillside, starting at the top of the slope on City property and continuing downward on the adjacent property to the toe of the slope. The failure debris was deposited over the lower part of the slope and across the adjacent property beyond the toe.

We initially visited the site on December 8 and 9, 2022, as requested by Mr. Gil Puffer, P.E. of Civil Engineering Consultants (CEC), to observe the failure. During our site visit on the 9th, we met with GeoStabilization International® (GSI®), a geotechnical contractor specializing in slope stabilization, to discuss emergency slope stabilization measures. A *Preliminary Geotechnical Assessment Report*, dated December 12, 2022, describing our observations, and providing preliminary recommendations for emergency slope repairs and further assessment of long-term slope stability conditions at the site, was submitted on December 13, 2022.

GeoStabilization International was contracted by the City to provide design/build emergency repairs of the upper part of the slope failure to allow refilling of the tanks. The repairs consisted of the installation of an approximate 100-foot long, 10-foot high permanent, shotcrete faced soil nail wall with vertical grouted micropiles. GSI's repair work was initiated during the week of December 19, 2022, and was completed about January 17, 2023.

Six soil test borings were completed along the top of the slope at the site on December 28 and 29, 2022 by our drilling subcontractor, Kilman Bros, Inc. Supplementary laboratory testing of selected soil samples from the soil test borings was completed on January 10, 2023. Civil Engineering Consultants provided a *Topography Exhibit* drawing, dated February 24, 2023, that shows the existing topography of the site area and property boundaries of the tank site. A GeoSystems subconsultant, Collier Geophysics, LLC (Collier) conducted a geophysical investigation at the site and their *Geophysical Letter Report* was provided on March 17, 2023. GeoSystems has been providing regular slope stability inspections at the site since completion of the emergency repairs. No significant changes in the slope conditions have been observed since our initial stability inspection on January 25, 2023.



SOURCE:		GEOSYSTEMS ENGINEERING, INC.	SITE MAP	
USGS Cumming Quardangle, Georgia, 7.5 Minute, 1999			PROJECT: CITY OF CUMMING, GEORGIA HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE 921 Canton Highway, Cumming, Georgia GeoSystems Project Number: 22-2875	FIGURE: 1
PREPARED BY: GEI	DATE: 4/3/2023			
REVIEWED BY: LDM	DATE: 4/3/2023	REFERENCE: Site MAP.dwg		

SITE CONDITIONS

The Sawnee tank site at 921 Canton Highway is located approximately 2 miles northwest of downtown Cumming. Two ground storage water tanks, with reportedly 500,000 and 800,000 gallon capacities, are located southwest of the highway along a narrow, northeasterly-southwesterly oriented ridgeline. The ridgeline slopes up from the highway at about elevation 1324 feet to over 1500 feet southwest of the site. Historic aerial photographs show the smaller easternmost tank was apparently constructed between 1972 and 1974 and the second tank was constructed between 1974 and 1981. The assess road to the tanks extends about 700 feet directly off the highway to the location of the tanks. Undeveloped woodlands are located along the ridgeline on the northwest side and Blount Construction operates an asphalt plant along the southeast side. The property line along the southeast side of the tank site is located within 10 to 15 feet from the edge of the tanks.

Site topography slopes upward to the southwest along the ridgeline and the indicated ground surface elevations at the location of the tanks varies from about 1388 to 1390 feet. The natural slope along the northwest side of the ridge appears to be 35 to 40 percent but is somewhat steeper immediately adjacent to the tank pad. A paved trail is located on the northwestern slope 50 to 60 feet beyond the tank pad.

The slope on the southeast side of the existing tanks, southwest of the slope failure, is very irregular and broken up with benches, erosion gullies and various surface irregularities. The immediate slope below the tanks above elevation 1326 to 1330 feet generally varies between 60 and 80 percent ($\pm$1.67 to 1.25H:1.0V). The lower slope is somewhat flatter, with areas varying from about 25 to 70 percent. A relatively moderately sloping, 25 to 35-foot wide bench is located generally between elevations 1320 and 1330 feet along most of the lower slope but narrows approaching the existing failure scarp. Another smaller bench located between elevations 1302 and 1310 extends about 70 feet immediately southwest of the failure scarp. Total relief of the slope in this area is 92 to 94 feet, varying from high elevation of 1388 and 1390 feet at the tank pad to 1296 feet at the toe on the Blount Construction property. The top of the slope is located about 10 feet from the edge of the tanks. The southeast slope, northeast of the slope failure, appears more uniform with slopes varying approximately from near 100 percent (1.0H:1.0V) at the top to 50 percent (2.0H:1.0V) near the bottom. The average slope of the entire hillside appears to be 60 to 65 percent and the total relief is about 72 feet, varying from a high elevation of 1370 feet at the top to 1298 feet at the toe.

Based on the 1964 USGS Cumming, Georgia topographic map, a quarry was located on the adjacent property southeast of the tank site. Review of city directories shows that Blount Construction occupied this property in 1995. Historic aerial photos in 1988, 1992 and 1999 show similar land use, indicating that Blount was the tenant to at least 1988. During the previous quarry operation and subsequently during Blount's occupation of the adjacent property, it appears the natural southeast slope was excavated somewhat steeper than currently indicated. Fill appears to have been placed back on the cut slope face to form the existing ground surface along the entire slope on the southeast side of the tank site. Historic aerial photographs show various disturbances of the slope from 1955 through 1999. Following the previous grading activities, the slope appears to have revegetated naturally with pine trees and sparse undergrowth.

Our observations during several site visits show indications of long-term slope movements and instability of the southeast slope below the tank site. Small, relatively shallow, slope failure scarps and erosion gullies were observed at a number of locations along the slope face. During our initial site visit, following the December 2022 slope failure, surficial failure scarps were observed at the top of the slope directly below the existing water vault. The soil nail wall emergency slope stabilization measure completed by GSI was installed through the old scarps at that location. A somewhat larger scarp was observed on the slope between elevations 1340 and 1360, directly downhill of the tanks. A large erosion gully exists below this scarp. In addition to these features, tree growth on the slope indicates downhill movement or creeping of the hillside. The relevant tree growth includes curved trunks, straight trunks leaning downhill, toppled trees, and a significant number of dead trees falling over randomly about the slope. At least nine cast iron pipes and one steel beam were previously installed vertically into the ground along the slope below the tanks, apparently in an attempt to mitigate the slope movements.

The massive slope failure that occurred at the site during the night of December 6, 2022, resulted in a large, relatively shallow scarp with translational movement that extended downward across the entire length of the hillside from the top of the slope to the toe. Joint separation of the water pipe serving the two tanks occurred during the failure and the contents of both tanks were discharged onto the slope. Mud and forest landside debris were deposited over the lower part of the slope and across the adjacent Blount Construction property beyond the toe.

Overburden soils in the upper portion of the failure were eroded and a very steep to near vertical scarp was formed in the underlying natural soils at the top. The scarp at the top of the slope was located 20 to 25 feet southeast of the 500,000 gallon tank. Visual observation during our initial site visit indicated undisturbed residual soils, partially weathered rock (PWR) or rock conditions were exposed in the failure scarp.

As noted in the previous section, GeoStabilization International performed emergency repairs of the upper part of the slope failure. The repair work was initiated during the week of December 19, 2022, and was completed about January 17, 2023. The repairs consisted of the installation of an approximate 100-foot long, 10-foot high permanent, soil nail wall with shotcrete facing. Vertical, grouted micropiles were initially installed on approximate 18-inch centers along the back of the planned wall location. The micropiles extended about 20 feet below the ground surface into undisturbed natural soils. Three rows of soil nails, typically 18 feet in length, were then installed prior to placement of the shotcrete facing. Horizontal drains were incorporated in the wall typically at a spacing of 10 feet, center to center.

An Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package, Google Earth aerial photos, EDR City Directory Image Report and historic USGS topographic maps are included in Appendix A – Historic Site Information Data. The *Topography Exhibit* drawing, recent pertinent photographs and GSI's *Slope Stabilization Plans,* dated December 12, 2022, showing current site topography, site conditions since the December slope failure and emergency slope repair details described in this section are enclosed in Appendix B – Existing Site Conditions Documentation.

GEOTECHNICAL ASSESSMENT METHODOLOGY

GeoSystems performed this geotechnical assessment based on our prior experience, knowledge, and professional judgment consistent with the standard of care and customary practice provided by geotechnical engineers practicing in the same geologic setting under the same or similar circumstances for projects of this type. Our assessment focused on the City's Sawnee tank site and the hillside located along the southeast side of the tanks on the adjacent property. Our field exploration was limited due to personal safety concerns and lack of access for conventional geotechnical exploration equipment and methods due to the existing site conditions.

Available property documents and published information were initially reviewed to determine general site conditions, historic land uses and geology of the site. Included were current and past USGS topographic maps, geologic reports/maps, historical aerial photographs of the site area and historic city directories. Environmental Data Resources, on behalf of GeoSystems, provided an Aerial Photo Decade Package and City Directory Image Report for the site. Aerial photographs of the site and surrounding area flown in 1938, 1951, 1955, 1972, 1974, 1981, 1988, 1999, 2007, 2010, 2015 and 2019 were provided by EDR. Additional historic aerial photographs were reviewed online and 1992, 2008 and 2018 photos from Google Earth were downloaded for this report. Property information for the adjacent 911 Canton Highway parcel was researched through the Forsyth County Board of Tax Assessors web site public records database.

Field Exploration/Laboratory Testing

Subsurface conditions at the site were mainly investigated by drilling six soil test borings (B-1 through B-6) at the approximate locations shown on the enclosed *Boring Location Plan* (Figure 2). Figure 2 was prepared from the *Topography Exhibit* drawing, dated February 24, 2023, provided by CEC. A GeoSystems engineer established the boring locations in the field by measuring distances and angles from existing site features. Boring elevations are the reported surveyed elevations rounded to the nearest 1.0-foot.

All soil sampling and standard penetration testing were performed in general accordance with ASTM standard D 1586. The borings were advanced by mechanically rotating hollow-stem augers into the ground and soil samples were obtained at regular intervals with a standard 1.4-inch I.D., 2-inch O.D. split-barrel sampler. Standard penetration testing was conducted at regular intervals in the borings to evaluate relative density or consistency of the soils and obtain samples for classification. At each sample interval, penetration tests were performed by first seating the split-spoon sampler 6 inches to penetrate any loose cuttings and then driving an additional foot with blows from a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler the final foot was recorded and is designated the "standard penetration resistance," or "N" value. Penetration resistance, when properly evaluated, is an index of the soil's strength.

Borings B-1 through B-4 were advanced to termination depths varying from 10 to 20 feet below the existing ground surface. Borings B-5 and B-6 were extended to hollow-stem auger refusal at depths of 27 and 48 feet, respectively. In addition to the split-spoon samples from the borings, one undisturbed Shelby-tube sample of indicated medium dense silty sand was recovered at a depth of 5

to 7 feet in an auger boring offset slightly from the original boring B-6 location. A laboratory consolidated undrained (CU) triaxial test (ASTM D4767) was performed on the undisturbed soil sample to help estimate insitu shear strength of the overburden soils.

The split-spoon soil samples collected in the field were first logged by the driller and then returned to our laboratory. All samples recovered during the field investigation were visually classified in the laboratory by a geotechnical engineer under the direction of a senior geotechnical engineer. In addition to visual classifications, limited laboratory index testing was performed on ten split-spoon samples to confirm the engineer's descriptions. The laboratory soil index testing consisted of particle size analysis (ASTM D6913) and Atterberg limits (ASTM D4318).

The enclosed test boring records represent our interpretation of the field conditions based on the driller's field logs and laboratory examination of the soil samples. Included are soil descriptions and unified classifications, graphical plots of the standard penetration resistances, and groundwater conditions encountered at the time of drilling. The lines designating the interfaces between various strata represent approximate boundaries only, as transitions between materials may be gradual.

In addition to the soil test borings, six hand auger borings (HAB-1 through HAB-6) were drilled into the subsurface at test locations on the existing slope, west of the failure scarp. The borings were extended to depths varying from a few inches to a maximum of 8.4 feet below the existing ground surface. Subsurface materials encountered in the hand auger borings were described from visual examination of the cuttings brought to the ground surface in the auger bucket. The boring data are presented on the attached *Hand Auger Boring Data Summary*.

Brief descriptions of the field and laboratory procedures are presented in Appendix C. The boring location plan, subsurface profiles, soil test boring logs and hand auger boring data summary are included in Appendix D. The laboratory test data are attached in Appendix E.

Geophysical Survey

A geophysical survey of the existing slope southwest of the failure scarp, where soil test borings could not be completed, was conducted by Collier Geophysics, LLC. The geophysical survey consisted of two P-wave velocity (Vp) and shear-wave velocity (Vs) lines to characterize the subsurface conditions along the slope. One line extended approximately 200 feet from near the top of the slope adjacent to the tank site to near the toe of the slope. The second line was about 300 feet in length and extended from across the tank pad at the crest of the hill to near the toe of the slope on the southeast side. The *Geophysical Letter Report*, dated March 17, 2023, describing the survey procedures, and presenting Collier's results is attached in Appendix F of this report.

AREA AND SITE GEOLOGY

Geologically, the site is in the northern section of the Piedmont Physiographic Province, an area underlain by ancient igneous and metamorphic rocks of the late Precambrian to early Paleozoic ages. Published geologic mapping indicates the site is an area where the Chatttahoochee Palisades Quartzite (cpq) rock unit has been mapped. Rocks in the Chatttahoochee Palisades Quartzite unit consist mainly of quartz schist. Schist is a strongly foliated crystalline rock formed by dynamic metamorphism.

The origin of the Paleozoic rocks, as sediments, has been obscured, due to their age and repeated cycles of weathering, metamorphism, folding, faulting, and injection with younger Paleozoic granites and Triassic diabase dikes. All of these rocks have weathered in place and are covered by a mantle of residual soils of varying thickness. Residual soils are formed insitu by chemical alteration of the underlying rocks. Normally, the weathering is most advanced near the ground surface and decreases with depth until unweathered parent rock is encountered. A transition from clay to silt to silty sand to partially weathered rock to hard rock is typical; however, this order of weathering is not always present. It is not uncommon to find layers or zones of partially weathered rock (PWR) or relatively unaltered rock pinnacles and boulders within the soil mantle or weathered rock layers within the underlying upper parent rock mass. The naturally developed soil profile may be changed by erosion and/or man's grading activities, so that the upper more weathered zones may be completely stripped away. Also, residual soils may be covered by washed-in alluvial soils or manmade fill, or both.

The deeper residual materials retain the relict structure of the original rock. Partially weathered rock materials have the appearance of sands in which the sand grains are individual mineral crystals that occupy the same positions as in the unaltered rock. Individual crystal breakdown occurs with further weathering and sandy silts or silty sands are formed. The original structure of the parent rock is preserved in these soils; however, the crystalline structure is altered or destroyed. Residual soils characterized by preservation of the relict structure that was present in the unweathered rock are termed saprolites.

Groundwater in the Piedmont generally occurs under water table conditions as a result of infiltration of rainwater and surface water through the somewhat permeable overburden. Groundwater occupies pore spaces and other secondary openings in the soil overburden and weathered rock and structural discontinuities, such as compositional layering and joints, in the rock. During infiltration, soil moisture and pellicular demands are first satisfied and any excess water percolates by gravity and pressure differences to the water table. Recharge also occurs by direct entry into structural discontinuities along saprolite or rock outcrops. Discharge takes place through springs and seeps in valley floors. In this geologic setting, the configuration of the groundwater table is generally expected to be a slightly subdued replica of the ground surface.

SUBSURFACE CONDITIONS

Soil Test Borings

The soil test borings encountered predominantly residual soils and partially weathered rock to boring termination or auger refusal depths. A 3-foot thick layer of possible fill soil was also encountered at the ground surface in borings B-1 and B-6. Fill is described as any material placed by man and the possible fill layer appears to be soils disturbed by recent rerouting of piping at the site. The possible fill consisted of loose silty sand (SM) with rock fragments.

Residual soils and partially weathered rock described in the previous site geology section, were encountered below the possible fill in borings B-1 and B-6 and below the ground surface in the remaining borings. The residual soils extended to the top of PWR at maximum depths of 20 and 38 feet in borings B-5 and B-6. The residuum was less than 8 feet deep in all remaining borings. The majority of the residual soils were classified as medium dense to dense silty sand (SM) and fine to coarse sand (SW), but some stiff to hard sandy silt (ML) and firm sandy clay (CL) were also identified. Penetration resistances recorded in the residual soil stratum ranged from a low of 8 to a high of 77 blows per foot (bpf) but were generally between 12 and 30 to 40 bpf.

Partially weathered rock (PWR) is residual material which can be penetrated by a power auger and has standard penetration resistances greater than 100 blows per foot. A continuous 8 to 12-foot layer of PWR was encountered below residual soils or from the ground surface to boring termination or auger refusal depths at all the boring locations. Borings B-1, B-2, B-3 and B-4 were terminated in PWR at depths varying from 10 to 20 feet. Partially weathered rock continued to refusal depths of 27 and 48 feet, respectively, in borings B-5 and B-6. The PWR is similar to the residual soils and was largely described as very dense silty fine to coarse sand (SM) or very dense fine to coarse sand (SW) with rock fragments.

Auger refusal is a designation applied to any material that cannot be further penetrated by the soil drilling process and is normally indicative of a very hard or very dense material, such as boulders, rock lenses, or the upper surface of bedrock. At this site, auger refusal was encountered in borings B-5 and B-6 at the depths below the ground surface noted above. Rock coring measures are required to penetrate and sample refusal material to determine the material character and continuity. Rock coring was not performed during this assessment; however, refusal of the hollow-stem augers at this site appears to be the top of bedrock.

Groundwater was not encountered in the soil test borings drilled at the site at the time of the field exploration. We note that depth to the water table is subject to climatic and seasonal variations and groundwater levels at other times and other locations may be different than the conditions indicated by this assessment.

Hand Auger Borings

The hand auger borings located on the existing slope encountered subsurface conditions consisting of apparent fill. Fill materials were initially encountered at all boring locations at the ground surface

and appeared to continue to termination or refusal depths varying approximately from 1.6 to 8.4 feet below the surface. Boring HAB-3 encountered auger refusal at a maximum depth of 1.6 feet on rocks or other obstructions in the fill. Several attempts were made at this location but the boring could not be extended further. The remaining borings were terminated at depths ranging from 3.4 to 8.4 feet due to difficult gravelly or rocky drilling conditions. The fill consisted of a loose upper layer classified generally as dark gray to black silty sand and gravel (SM/GM) containing rock fragments, and apparent asphalt waste. Below this layer, the fill appeared somewhat cleaner, but still contained various quantities of rock fragments, asphalt, roots, wood fragments and other unidentified organic matter.

Laboratory Test Results

Laboratory particle size analysis, Atterberg limits tests, and one consolidated undrained triaxial shear strength (CU) test were performed on selected split-spoon samples and the undisturbed Shelby-tube sample of residual soils recovered from the soil test borings. The laboratory test data show the natural soils consist of silty sands (SM) and sandy silts (ML) with some sandy clay (CL) near the ground surface. The percentage of fines (silt and clay) in the upper soils ranged approximately from 35 to 67 percent. Plastic limits (PL) of 24 and 36 percent and liquid limits (LL) of 43 and 48 percent were reported for two samples of CL and ML soils collected from borings B-4 and B-5. Below a depth of about 10 to 15 feet, the soils become more sandy and gravely with the percentage of fines typically ranging from about 16 to 21 percent. However, one sample collected from boring B-6 at 23.5 to 25 feet contained 40.3 percent fines. Most of the deeper soils appear to be non-plastic. Effective shear strength values of 105 psf for cohesion (c') and 38.7 degrees for the angle of internal friction (φ') are indicated for medium dense silty sand, based on the one triaxial test of residual soil collected at a depth of 5 to 7 feet at the location of boring B-6.

Geophysical Survey

The enclosed geophysical report by Collier discusses the results of P-wave velocity (Vp) and shear-wave velocity (Vs) profiles conducted along two lines located in the area southwest of the failure scarp at the site. One line (Profile 1) extended approximately 200 feet from near the top of the slope adjacent to the 500,000 gallon tank to near the toe of the slope. The second line (Profile 2) was about 300 feet in length and extended from across the tank pad at the crest of the hill between the two tanks to near the toe of the slope on the southeast side.

The quality of the data acquired during the survey was good; however, we note that due to geophysical survey limitations and since specific validation of the seismic data was not confirmed by soil test borings along the majority of the profiles, interpretation of the data was likely more difficult and uncertain, and interpretation of the various subsurface horizons remains somewhat speculative.

The subsurface conditions characterized by the survey data included overburden soils, partially weathered rock and unweathered rock. The overburden soils consist of undisturbed residual soils and fill that was previously placed at the site during reconstruction of the southeast slope. The existence of the fill was confirmed by our visual observations at the site and the shallow hand auger boring data.

The geophysical data indicates the overburden soils are significantly heterogenous with intermittent zones of varying Vp and Vs values. The Vp and Vs values of the less competent, apparent fill overburden, appear to be typically less than 3000 and 400 ft/sec, respectively. The depth of the less competent overburden below the ground surface is variable but generally averages about 10 feet. In the lower part of the slope, near the toe, the less competent overburden appears to be 20 feet or more in depth.

The top of partially weathered rock was interpreted to correspond to approximate values 4500 ft/s (Vp) and 800 ft/s (Vs) at a depth of approximately 20 feet below the surface. The thickness of the PWR stratum ranges approximately from 15 to 40 feet and appears greatest at the top and bottom of the slope along Profile 2. Unweathered rock was interpreted to correspond to Vp values greater than approximately 6500 ft/s and Vs values greater than approximately 1200 ft/s. The top of rock generally follows surface topography at depths of approximately 40 to 50 feet below ground.

DISCUSSION AND RECOMMENDATIONS

Slope Stability Analysis

A computerized stability analysis was conducted to evaluate the stability of the existing slope and provide a basis for an explanation of the December 2022 failure. The computer program STABLPRO for Windows, which enhances the STABL program originally developed at Purdue University was used for the analysis. This program performs two-dimensional limit equilibrium computations of the factor of safety (FOS) for a layered slope by balancing sliding and resisting forces along semi-randomly generated surfaces cut through sections of the slope. Slope stability safety factors were determined for two-dimensional cross-sections developed from the slope geometry and generalized subsurface conditions. The analyses were performed under static loading conditions. Vibrations from earthquakes or other induced dynamic forces were not evaluated. Dynamic loading conditions would reduce the embankment slope stability safety factors below those based on static loading conditions.

The Simplified Bishop method was initially used to generate relatively small shallow circular failure surfaces on the slope face that could trigger more massive translational movements along planes of weakness paralleling the slope. This method satisfies vertical force equilibrium for each slice and overall moment equilibrium about the center of the circular trial forces. Slope stability FOSs for circular failures were evaluated for the upper steeper portion of the slope generally above elevation 1340 feet. Safety factor values for failures limited to the slope face, below the top of slope were initially determined. Additional FOSs were determined for failure circles extending beyond the top of slope underneath the tanks. Specified failure surface searches were also performed to determine stability safety factors for translational slides along several sections of the slope and for the entire slope. Translational failures of the slope were modeled along the indicated interface between the shallow fill on the surface and the underlying residual soils. The interface is generally a planar surface prone to sliding.

Slope stability depends on many factors, with the slope angle and strength of the soils being of primary importance. Soil strengths used in this analysis were estimated from our previous experience, correlations with standard penetration test results and seismic velocity data, limited laboratory shear strength data from on test and the soil classification test results. Our analysis used the following generalized effective shear strength values for the angle of internal friction (φ’). A zero value for soil cohesion (c’) was assumed in all cases.

SOIL TYPE	FRICTION ANGLE (φ’) Degrees
Fill	25
Undisturbed residual soils	34
Partially Weathered Rock	45

Although interpretation of the existing slope conditions and the assumed soil strength parameters allow a conventional evaluation of the slope stability, there is a great degree of uncertainty in the results due to limited site-specific characterization of the subsurface conditions along the slope face and soil strength test data. However, the stability analysis likely indicates the range of safety factors against failure of the slope that exists for the various conditions.

In order to generate representative critical failure surfaces and factors of safety, we performed multiple computerized analysis runs by varying the defined limits of the trial failure surfaces along two representative slope profiles for the assumed subsurface conditions. The final stability analysis reports for three critical cases (Profile D-D' Runs 1, 2 and 5) are enclosed in Appendix G for your reference. We can provide the reports for all of the runs for your reference, if required. The graphics for each of the circular failure cases show 1) the most critical failure surface, 2) critical plus the next 10 most critical, and 3) all surfaces analyzed, along with the corresponding factor of safety for the most critical surface. Graphics for the translational failures indicate a single location of the specified failure surface. The following table summarizes the stability analysis results for all our runs:

PROFILE	RUN	STATIC FOS	NOTES	FAILURE TYPE
C-C'	1	0.92-1.03	1	Shallow Circular Above El. 1340 to top of slope
	2	1.12-1.59	2	Shallow Circular Above El. 1340 exiting from the top of slope through the tank foundation
	3	0.99	4	Translational Above El. 1330
	4	1.07	3	Translational Above El. 1308
	5	1.54	6	Translational Entire fill slope above El. 1296
D-D'	1	0.82-0.90	1	Shallow Circular Above El. 1340 to the top of slope
	2	1.08-1.24	2	Shallow Circular Above El. 1340 exiting from the top of slope through the tank foundation
	3	0.99	3	Translational Above El. 1310
	4	0.70	5	Translational Above El. 1340
	5	0.98	6	Translational Entire Fill Slope above El. 1296

Notes:

1. Shallow critical FOS circles in surficial fill layer.
2. Shallow critical FOS circles limited to termination beyond top of slope.
3. Critical FOS along interface of fill and residual soils above elevation 1308-1310 feet.
4. Critical FOS along interface of fill and residual soils above elevation 1330 feet.
5. Critical FOS along interface of fill and residual soils above elevation 1340 feet.
6. Critical FOS of entire slope along interface of fill and residual soils above elevation 1296 feet.

Our analysis indicates generally unstable slope conditions against small circular failures on the slope face and large translational failures along the fill/residual soil interface. Factor of safety values varying from slightly higher than 1.0 to less than 1.0 were generally found for most of these conditions. Somewhat higher values were found for circular failure surfaces extending underneath the tanks beyond the top of the slope. Factors of safety for these failures ranged from 1.12 to 1.59 for Profile C-C' and 1.08-1.24 for D-D'; however, FOSs of failure circles intersecting the tank foundations were greater than 1.4 for Profile C-C' and 1.16 for D-D'. A minimum safety factor value of 1.3 is generally satisfactory for the design of slopes supporting tanks and similar structures.

Slope Stability Discussion

The massive slope failure that occurred at the site in December 2022 is characteristic of translational landslides that occur when unstable conditions are present, and the sliding mass moves downward along a planar surface. In this case, previous excavations of the southeast hillside initially steepened the slope and increased the stresses in the soils along the slope. Partial restoration of the site was attempted by filling with asphalt waste, soil, and other undocumented materials back on the face of the cut slope; however, it appears this was done haphazardly and without properly tying the fill into the natural residual soils along the face of the slope. The interface between the fill and the underlying residual soils formed a planar, steeply sloping surface susceptible to sliding, particularly if saturated with water. In addition, the fill materials do not appear to be of good quality and proper compaction of these materials could not have been accomplished due to the site conditions. As a result, a weak layer of steeply sloping fill on the surface of the slope was created in which failure is likely to occur.

Our evaluation shows that instability of the southeast slope results in shallow circular failures on the slope face, similar to the old failure scarps previously observed at the site, and translational slides generally along the fill/residual soil interface. It is very difficult to determine the exact cause of a slope failure, as a single factor or a combination of countless factors can result in a loss of soil shear strength or an increase in the soil stress causing unstable conditions. Instability of the slope at this site, however, can be attributed to the excessive steepness of the slope, relatively weak or poor soil conditions within the overlying fill layer, a planar surface existing along the fill/residual soil interface susceptible to sliding and saturation of the soils on the slope with water.

Due to long-term movements or creep of the shallow overburden soils at the site, the pipe supplying water to the two tanks along the top edge of the slope progressively shifted downhill. Over time the pipe movements likely caused leaking of water from joints, increasing the water content of the soils, adding weight to the slope and lowering the strength of the overburden soils. In addition to water leaks from the supply pipe, over 3 inches of rainfall was reported on December 5 and 6, 2022, prior to the slope failure, by the USGS Big Creek gaging station near Cumming. The rainfall caused further saturation of the soils at the site. All these factors contributed to ultimate failure of one pipe joint and release of over 1.3-million gallons of water from the tanks onto the slope, resulting in the massive "mudslide" type of slope failure at the site.

In our opinion, there is a relatively high risk of failure of the southeast slope at any time during a perfect combination of the conditions described above or initiated by heavy rains, freeze-thaw, earthquakes or other triggering events. Risk of damage to the tanks or partial loss of foundation support due to progressive slope failures at the site is low to moderate. The smaller, easternmost tank is most susceptible to damage due to relatively low factors of safety for some failure circles intersecting the tank foundation. Complete failure of the tanks appears slight due to the relatively good, stable foundation support conditions consisting of undisturbed residual soils and shallow partially weathered rock.

Slope Repairs

We recommend the massive slope failure at the site be repaired by reconstructing the hillside to a slope no steeper than 2.0H:1.0V. In order to reconstruct the slope, all loose soils and landside debris in the area to be repaired must initially be removed prior to placement of any fill. The project geotechnical engineer should observe the conditions after the initial site preparation to confirm conditions are satisfactory for placement of the new engineered fill.

All engineered fill soil required for the slope repair should consist of low to moderately plastic soils that are free of deleterious materials and rocks larger than 3 inches in diameter. All fill soils must be evaluated by the project geotechnical engineer in advance of placement to confirm acceptance. Collection of a sufficient number of representative borrow samples must also be completed prior to construction in order to allow sufficient time for the necessary laboratory testing and engineering evaluation.

All engineered fill soil should be placed in maximum 6 to 8-inch lifts, loose measure, and compacted to at least 95 percent of the maximum dry density, as determined by the standard Proctor compaction test (ASTM D-698). Soil moisture during placement should be maintained within ±3 percent of the standard Proctor optimum moisture content.

Engineered fill should not be placed on a frozen subgrade and no snow, ice, or other frozen material can be mixed into the fill soil. The fill should be placed in individual horizontal fill lifts and compacted with sheep-foot roller type compaction equipment that are fitted with projecting studs that penetrate into the fill. The surface of each fill lift must be left rough to provide adequate bonding with subsequent fill lifts; however, the fill surface should be sealed at the end of each work day by rolling with rubber-tired or smooth drum compaction equipment. The sealed surface must then be scarified at the beginning of the next work day, before the placement of any subsequent lifts of fill. If the top surface of a preceding layer of compacted fill becomes too dry to permit a suitable bond with new fill placement, the preceding layer should either be removed or scarified and moistened to an acceptable level prior to any additional fill placement.

Benching or keying of the new engineered fill into the existing slope is critical in order to bond the fill to the existing slope and reduce the risk of possible future slope stability problems. Compaction of fill on the existing slope will not be possible without benching and inadequately compacted fill is susceptible to erosion and sliding failure. The interface between the existing slope and the new fill also creates a potentially weak continuous plane, which is also susceptible to translational sliding

shear failure. Benching is a "stair-step" method of construction, which improves stability by hindering the development of a shear plane along the interface.

Benching is accomplished by cutting or notching horizontal benches into the existing slope with a dozer blade or front end loader bucket. The procedure is started by excavating a typical 2 to 3-foot (maximum) deep thrust trench or keyway into competent residuum at the toe of the new fill slope. The keyway is then backfilled and compacted to the level of the next slope bench. Benches are cut into the existing slope to a sufficient width to bond the new fill to the existing slope and to accommodate operation of the compaction equipment and proper placement and compaction of the new engineered fill. The maximum width and height of the benches are limited to assure the slope remains stable during construction. The benching process is repeated up the slope until reaching the top.

During the fill placement, monitoring is required to confirm proper benching into the existing slope, proper fill placement measures are being used, and the degree of compaction and moisture content requirements are achieved throughout the entire engineered fill placement. One to two in-place density tests should be performed for each vertical 2 feet of fill placed. Any areas that do not comply with the compaction requirements during the earthwork construction should be re-compacted until compliance is met.

Instrumentation

Considering the unstable nature of the southeast slope and possible impact of slope failure on the existing tanks, we recommend installation of inclinometers at the site to provide long-term monitoring of lateral earth movements. Installation of these instruments will offer a means for additional characterization of the subsurface conditions and allow a more rational evaluation of the slope stability. At least three in-place inclinometers should be installed along the top edge of the southeast slope on the tank site. If possible, additional inclinometers should be installed on the adjacent property slope in line with the tank site instruments. The inclinometers will be remotely monitored continuously for the magnitude, direction, and rate of subsurface lateral movements. Real-time monitoring will provide early warning of impending slope failure and determine the need for any corrective actions required to protect the tanks.

Installation of the in-place inclinometers will include placement of a string of sensors permanently in a special-purpose grooved casing installed vertically in a borehole drilled into PWR or rock below the anticipated area of movement. The internal grooves in the casing control the orientation of the inclinometer sensors or a wheeled inclinometer probe, used to determine the initial position of the casing. The sensors are placed at regular intervals in the casing and are connected to a data acquisition system that continuously monitors movements and can trigger an alarm if the rate of movement or amount of displacement exceeds preset values.

QUALIFICATION OF RECOMMENDATIONS

This report has been prepared for the exclusive use of Civil Engineering Consultants and the City of Cumming. Conclusions and recommendations in this report were based on the available site information, our observations of the site conditions, interpretation of the soil test boring and laboratory test data and our experience with similar site and subsurface conditions. We note that regardless of the thoroughness of a geotechnical exploration, there is the possibility that conditions between test locations will differ from those at the actual test locations, that conditions are not as anticipated, or that the construction process has altered the soil conditions. If conditions differing from those anticipated are encountered during the course of the slope repairs, GeoSystems should review the changed conditions to develop any required revisions to our recommendations.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. This company is not responsible for the conclusions, opinions or recommendations of others based on these data. If the background or site conditions information described in this report is incorrect, we request the opportunity to review our recommendations in consideration of the correct data.

APPENDIX A

HISTORIC SITE INFORMATION DATA

Cumming - Highway 20 Slope Failure

921 Canton Highway Aka Georgia Highway 20

Cumming, GA 30040

Inquiry Number: 7209715.1

December 21, 2022

The EDR Aerial Photo Decade Package

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

12/21/22

Site Name:

Cumming - Highway 20 Slope I
921 Canton Highway Aka Geo
Cumming, GA 30040
EDR Inquiry # 7209715.1

Client Name:

GeoSystems Engineering, Inc.
11285 Elkins Rd Suite F2
Roswell, GA 30076
Contact: Larry D. Mullins

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

Search Results:

Year	*Scale*	*Details*	*Source*
2019	1"=500'	Flight Year: 2019	USDA/NAIP
2015	1"=500'	Flight Year: 2015	USDA/NAIP
2010	1"=500'	Flight Year: 2010	USDA/NAIP
2007	1"=500'	Flight Year: 2007	USDA/NAIP
1999	1"=500'	Acquisition Date: January 01, 1999	USGS/DOQQ
1988	1"=500'	Flight Date: January 28, 1988	USGS
1981	1"=500'	Flight Date: March 06, 1981	USDA
1974	1"=500'	Flight Date: April 16, 1974	USGS
1972	1"=500'	Flight Date: February 10, 1972	USDA
1955	1"=500'	Flight Date: March 09, 1955	USGS
1951	1"=500'	Flight Date: April 17, 1951	USGS
1938	1"=500'	Flight Date: March 07, 1938	USDA

When delivered electronically by EDR, the aerial photo images included with this report are for ONE TIME USE ONLY. Further reproduction of these aerial photo images is prohibited without permission from EDR. For more information contact your EDR Account Executive.


INQUIRY #: 7209715.1
YEAR: 2019
= 500'
N
EDR

INQUIRY #: 7209715.1

YEAR: 2015

= 500'

N

EDR

INQUIRY #: 7209715.1

YEAR: 2010

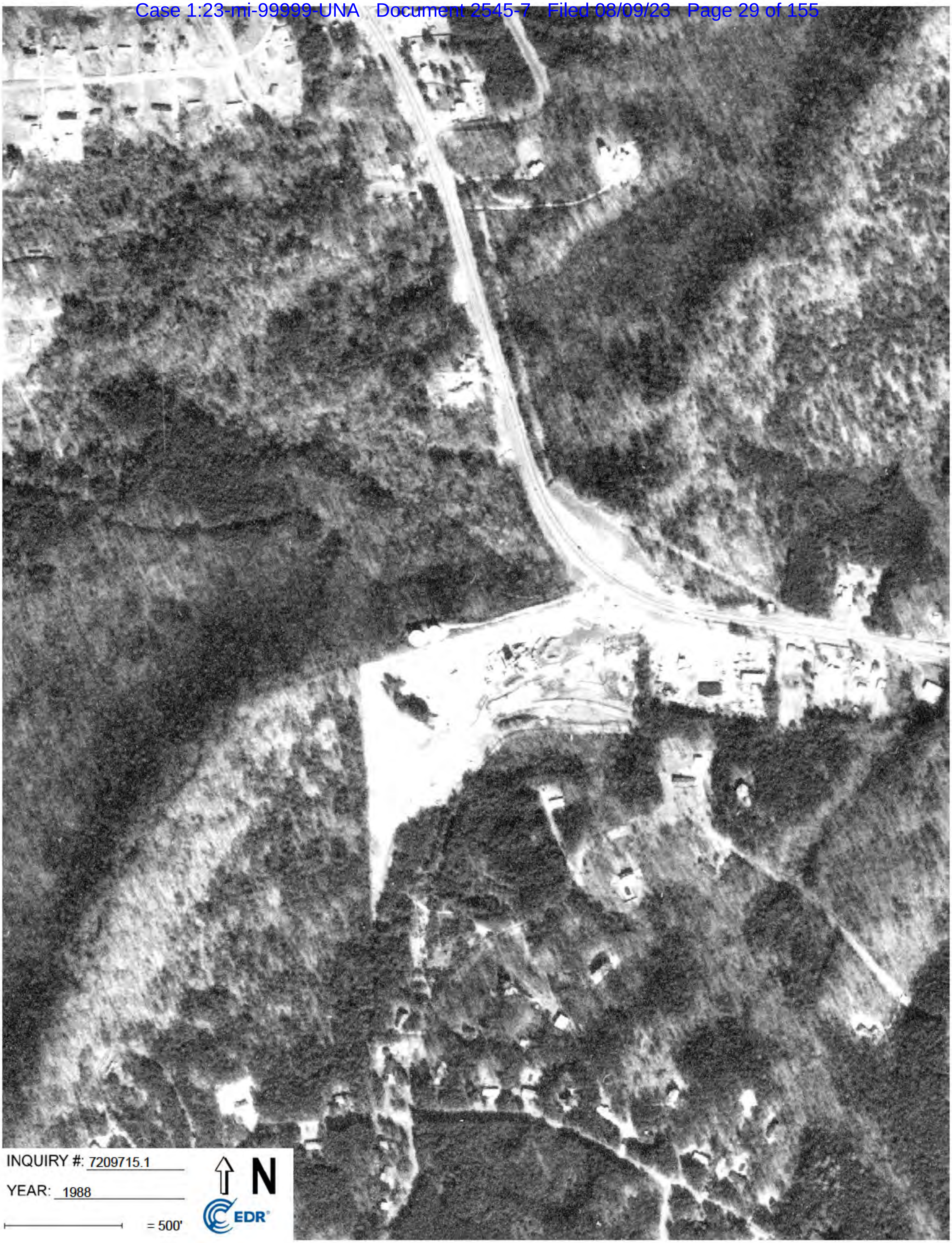
= 500'

N

EDR


INQUIRY #: 7209715.1
YEAR: 2007
= 500'
N
EDR


INQUIRY #: 7209715.1
YEAR: 1999
= 500'
N
EDR



INQUIRY #: 7209715.1

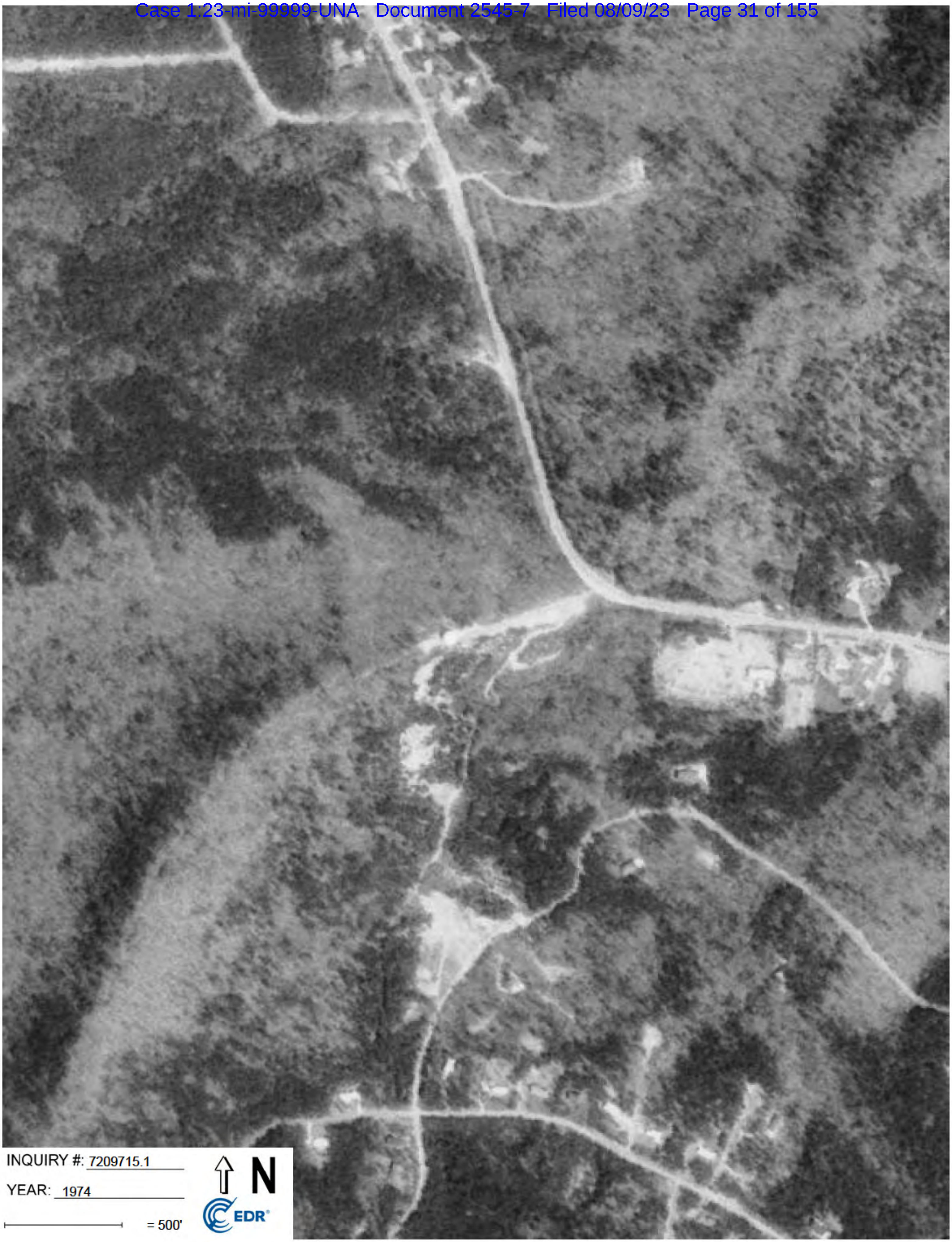
YEAR: 1988

= 500'

N

EDR


INQUIRY #: 7209715.1
YEAR: 1981
= 500'
N
EDR



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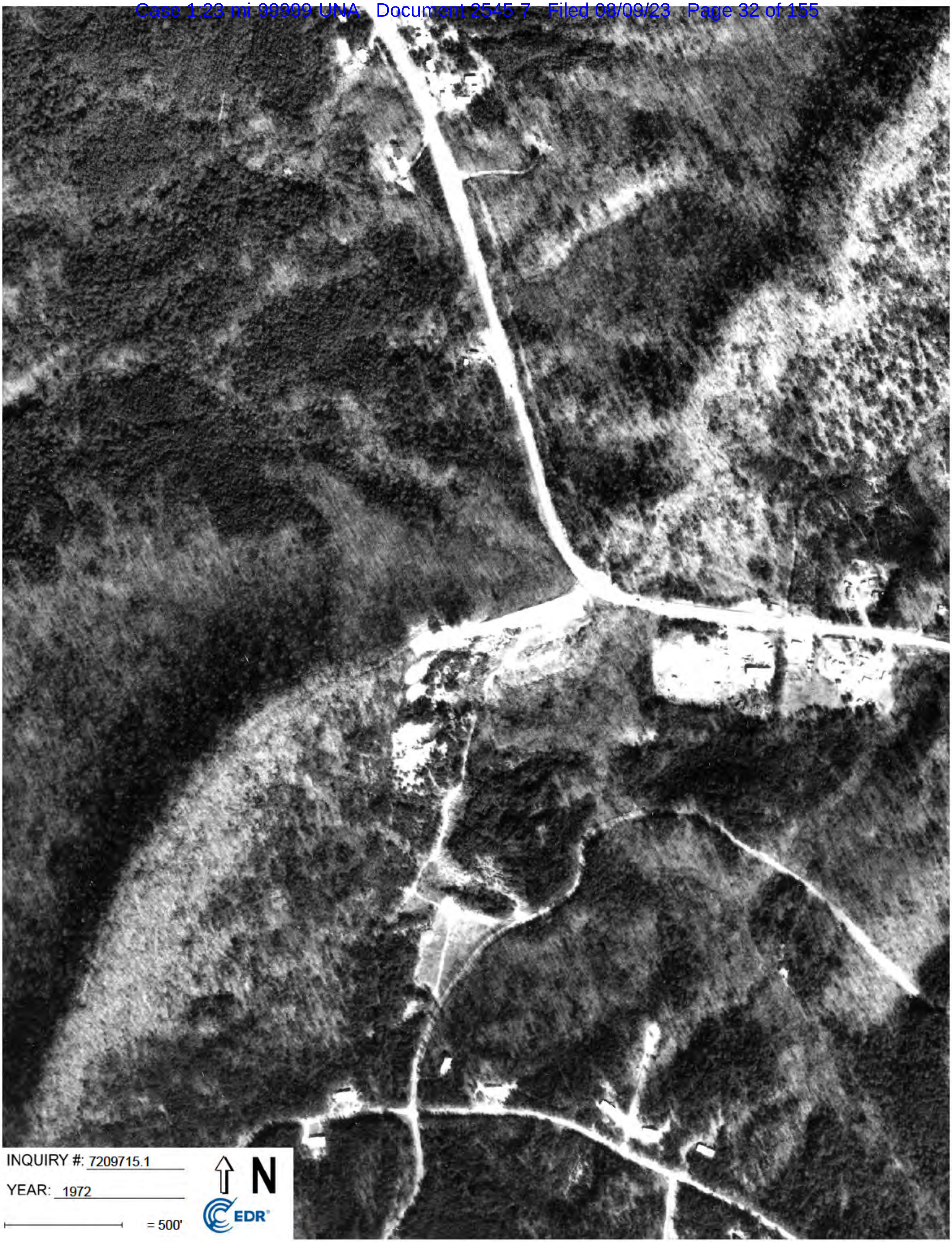
YEAR: 1974

= 500'

N

EDR



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YEAR: 1972

= 500'

N

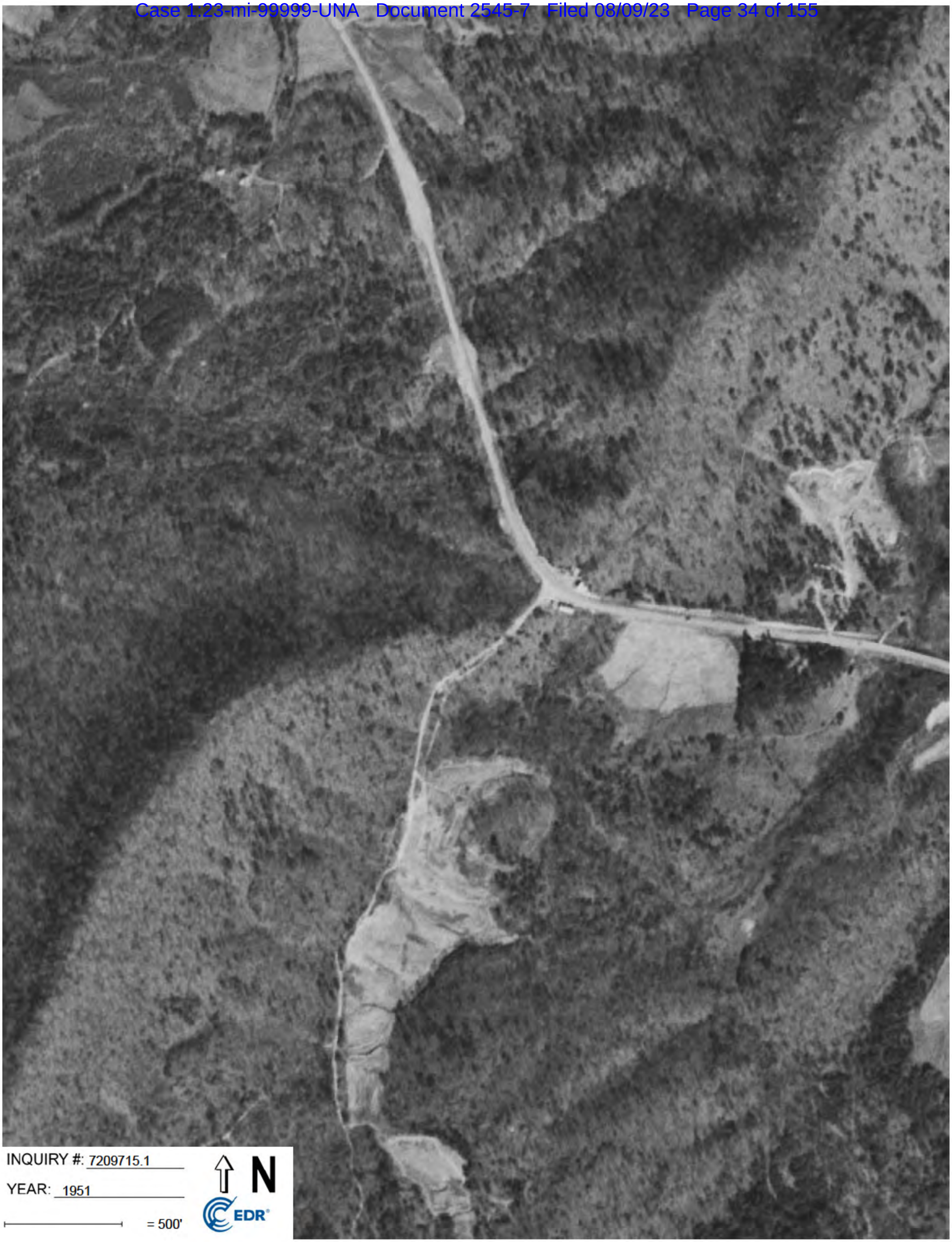
EDR

INQUIRY #: 7209715.1

YEAR: 1955

= 500'

N



INQUIRY #: 7209715.1

YEAR: 1951

= 500'

N

EDR

INQUIRY #: 7209715.1

YEAR: 1938

= 500'

N

EDR


1992 AERIAL
Sawnee Tank Site
Legend
921 Canton Hwy
Feature 1
Overlook Springs Ln
Sawnee Gap
20
921 Canton Hwy
Blount Construction
Google Earth
900 ft

Legend
Feature 1
2008 Google Earth
Sawnee Tank Site
Sawnee Gap
20
Blount Construction
Greenwood Acres Dr
700 ft
N
Google Earth

2018 Google Earth
Sawnee Tank Site
Legend
Feature 1
N
700 ft
Sawnee Gap
20
Blount Construction
Greenwood Acres Dr
Google Earth

Cumming - Highway 20 Slope Failure
921 Canton Highway Aka Georgia Highway 20
Cumming, GA 30040

Inquiry Number: 7209715.2
December 23, 2022

The EDR-City Directory Image Report

EDR® Environmental Data Resources Inc

6 Armstrong Road
Shelton, CT 06484
800.352.0050
www.edrnet.com

TABLE OF CONTENTS

SECTION

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

DESCRIPTION

Environmental Data Resources, Inc.'s (EDR) City Directory Report is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's City Directory Report includes a search of available city directory data at 5 year intervals.

RECORD SOURCES

EDR's Digital Archive combines historical directory listings from sources such as Cole Information and Dun & Bradstreet. These standard sources of property information complement and enhance each other to provide a more comprehensive report.

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Data by infoUSA

RESEARCH SUMMARY

The following research sources were consulted in the preparation of this report. A check mark indicates where information was identified in the source and provided in this report.

Year	***Target Street***	***Cross Street***	***Source***
2017	☑	☐	EDR Digital Archive
2014	☑	☐	EDR Digital Archive
2010	☑	☐	EDR Digital Archive
2005	☑	☐	EDR Digital Archive
2000	☑	☐	EDR Digital Archive
1995	☑	☐	EDR Digital Archive
1992	☑	☐	EDR Digital Archive
1986	☐	☐	Haines Criss-Cross Directory
1981	☐	☐	Haines Criss-Cross Directory
1976	☐	☐	Haines Criss-Cross Directory
1970	☐	☐	Haines Criss-Cross Directory
1966	☐	☐	Haines Criss-Cross Directory

FINDINGS

TARGET PROPERTY STREET

921 Canton Highway Aka Georgia Highway 20
Cumming, GA 30040

Year	***CD Image***	***Source***	
CANTON HWY			
2017	pg A1	EDR Digital Archive	
2014	pg A2	EDR Digital Archive	
2010	pg A3	EDR Digital Archive	
2005	pg A4	EDR Digital Archive	
2000	pg A5	EDR Digital Archive	
1995	pg A6	EDR Digital Archive	
1992	pg A7	EDR Digital Archive	
1986	-	Haines Criss-Cross Directory	Street not listed in Source
1981	-	Haines Criss-Cross Directory	Street not listed in Source
1976	-	Haines Criss-Cross Directory	Street not listed in Source
1970	-	Haines Criss-Cross Directory	Street not listed in Source
1966	-	Haines Criss-Cross Directory	Street not listed in Source

FINDINGS

CROSS STREETS

No Cross Streets Identified

City Directory Images

CANTON HWY 2017

759	LANIER AUTO REPAIR & RESORATION LL
	UHAUL
770	CUMMING FIRST UNITED METHODIST
803	STRAYHORN, WILLIAM J
804	MILLER, WYNETTE S
823	LUCHETTI, JOHN J
911	BLOUNT CONSTRUCTION CO INC
1107	CUMING HOME MINISTRIES
	DUNKLEY, JOHN
1110	WALLACE, BILLY C
1133	MARTIN, SHERMAN E
1220	MARTINEZ, JOSE R
1240	CHUMLEY, JACKY M
1241	LEAPHART, EDWARD W

CANTON HWY 2014

759	LANIER AUTO REPAIR & RESORATION LL
	UHAUL
770	CUMMING FIRST UNITED METHODIST
	CUMMING FIRST UNITED METHODIST PRESC
779	STRAYHORN, WILLIAM D
781	OCCUPANT UNKNOWN,
803	STRAYHORN, WILLIAM J
804	MILLER, WYNETTE S
823	LUCHETTI, JOHN J
911	BLOUNT CONSTRUCTION CO INC
993	HAMPTON, ERIC
1011	BUILDING BLOCKS CHILD DEVELOPMENT CE
1107	BARRY, ELLIS C
1110	WALLACE, BILLY C
1133	MARTEN, MARY L
1220	OCCUPANT UNKNOWN,
1230	OCCUPANT UNKNOWN,
1240	CHUMLEY, JACKY M
1241	BLANCO, ROBERTO

Target Street	Cross Street	Source
-	-	EDR Digital Archive

CANTON HWY 2010

759	B & L AUTOMOTIVE INC
	UHAUL CO
779	STRAYHORN, WILLIAM D
781	OCCUPANT UNKNOWN,
803	STRAYHORN, WILLIAM J
804	MILLER, WYNETTE S
823	BURT, NICOLE
840	OCCUPANT UNKNOWN,
911	BLOUNT CONSTRUCTION CO INC
1011	BUILDING BLOCKS CHILD DEVMNT
1021	ANDERSON, MARVIN S
1110	WALLACE, BILLY C
1133	MARTIN, SHERMAN E
1210	OCCUPANT UNKNOWN,
1220	SMITH, ROBERT
1230	MONPIERE, RICARDO
1240	CHUMLEY, JACKY M
1241	OCCUPANT UNKNOWN,

CANTON HWY 2005

770	CUMMING FIRST UNITED METHODIST PRESC
779	STRAYHORN, WILLIAM D
781	MARTINEZ, EDMA
803	STRAYHORN, WILLIAM D
804	MILLER, LEAMON E
823	TAPP, ROY L
911	BLOUNT CONSTRUCTION CO INC
1011	DISCOVERY POINT CHILD DEV CENTER
1021	ANDERSON, MARVIN S
1104	WILLARD, ZEKE
1106	PAYTON, STEVE
1107	MULLIS, TERRI E
1110	WALLACE, BILLY C
1133	MARTIN, SHERMAN E
1210	LOMAX, SCOTT S
1220	SARMIENTO, ALICIA
1230	THAXTON, DWIGHT D
1240	CHUMLEY, JACKY M
1241	PITTS, LAURI A

Target Street	Cross Street	Source
✓	-	EDR Digital Archive

CANTON HWY 2000

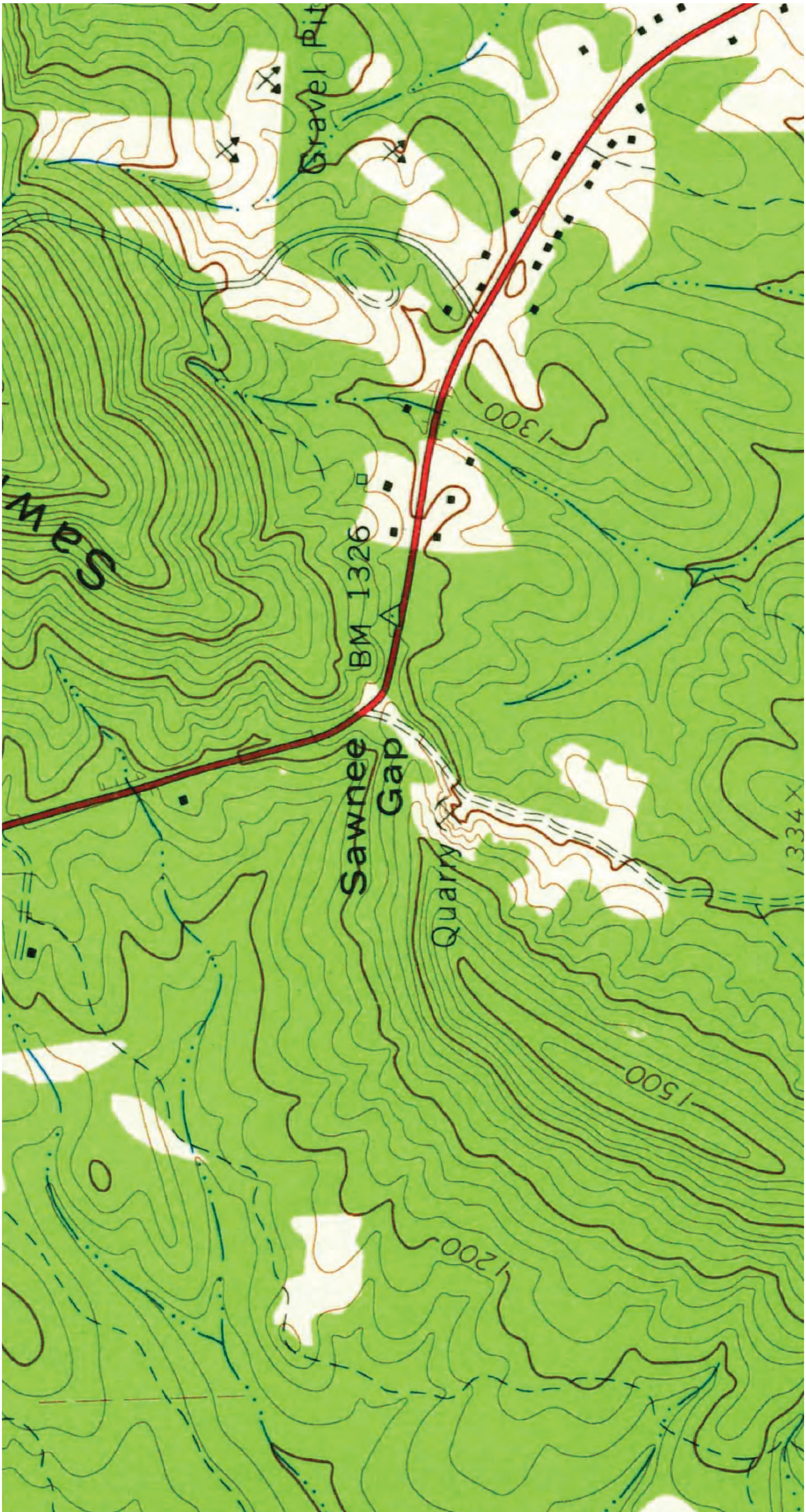
759	NORTH GEORGIA RECYCLING
770	CUMMING FIRST UNITED METHODIST CHURCH
	CUMMING FIRST UNITED METHODIST PRESCHOOL
779	STRAYHORN, WILLIAM
781	STONE, NELLIE M
803	STRAYHORN, WILLIAM
804	ALVIS, STEWART C
823	TAPP, ROY L
840	MELTON, JAMES B
843	FORSYTH COUNTY OF ROADS & BRIDGES
915	BOLING, LOIS
1106	CHILTON, N
	MERCK, JAMES
1107	BABB, THOMAS G
1110	WALLACE, BILLY C
1133	MARTIN, SHERMAN
1170	WALTON, BARRY W
1204	FORSYTH CNTY OF GEORGIA FOR COMM FORSYTH FOR UNIT
	GEORGIA STATE GOVERNMENT FORESTRY COMMISSION
1210	REAGAN, CAROLYN
1220	DOMINGUEZ, MERY
1230	OCCUPANT UNKNOWN,
1240	CHUMLEY, JACKY
1241	WALKER, GREG

CANTON HWY 1995

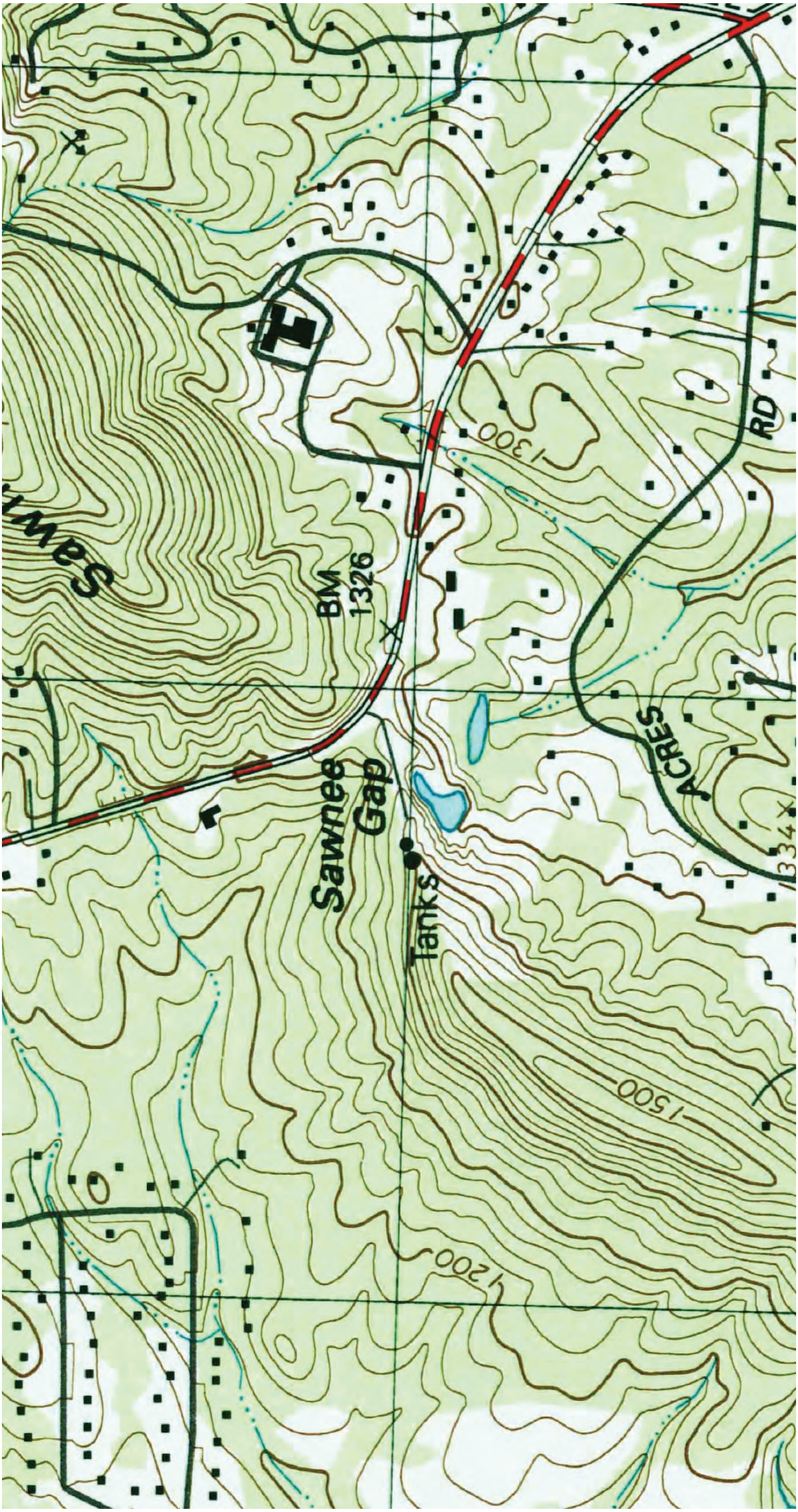
759	M & M RECYCLING
770	CUMMING UNITED METH PRE SCHOOL
	CUMMING UNITED METHODIST CHR
779	STRAYHORN, WILLIAM
781	STONE, NELLIE M
794	ALVIS, STEWART C
803	STRAYHORN, WILLIAM
804	ALVIS, STEWART C
823	TAPP, ROY L
840	OCCUPANT UNKNOWNN
911	BLOUNT CONSTRUCTION CO
915	BOLING, LOIS
1011	LITTLE PEOPLE & FRIENDS INC
1021	BURNS, GRAYSON
1106	OCCUPANT UNKNOWNN
1107	THORN, PAIGE
1110	WALLACE, BILLY C
1133	MARTIN, CLYDE E
1204	FORESTRY COMMISSION
1210	WALLACE, GREG E
1220	HALL, LEIGH A
1230	HANSARD, BARBARA
	MARTIN, MARCUS
1240	CHUMLEY, JACKY
1241	PITTS, MACK E

CANTON HWY 1992

760	HOLBROOK, R C
804	ALVIS, STEWART C
840	MELTON, JAMES B
1107	BABB, THOMAS G
1110	WALLACE, BILLY C
1133	MARTIN, EDDIE
1230	HANSARD, BARBARA
	MARTIN, MARCUS
1240	CHUMLEY, JACKY
1250	HEAD, ARTHUR



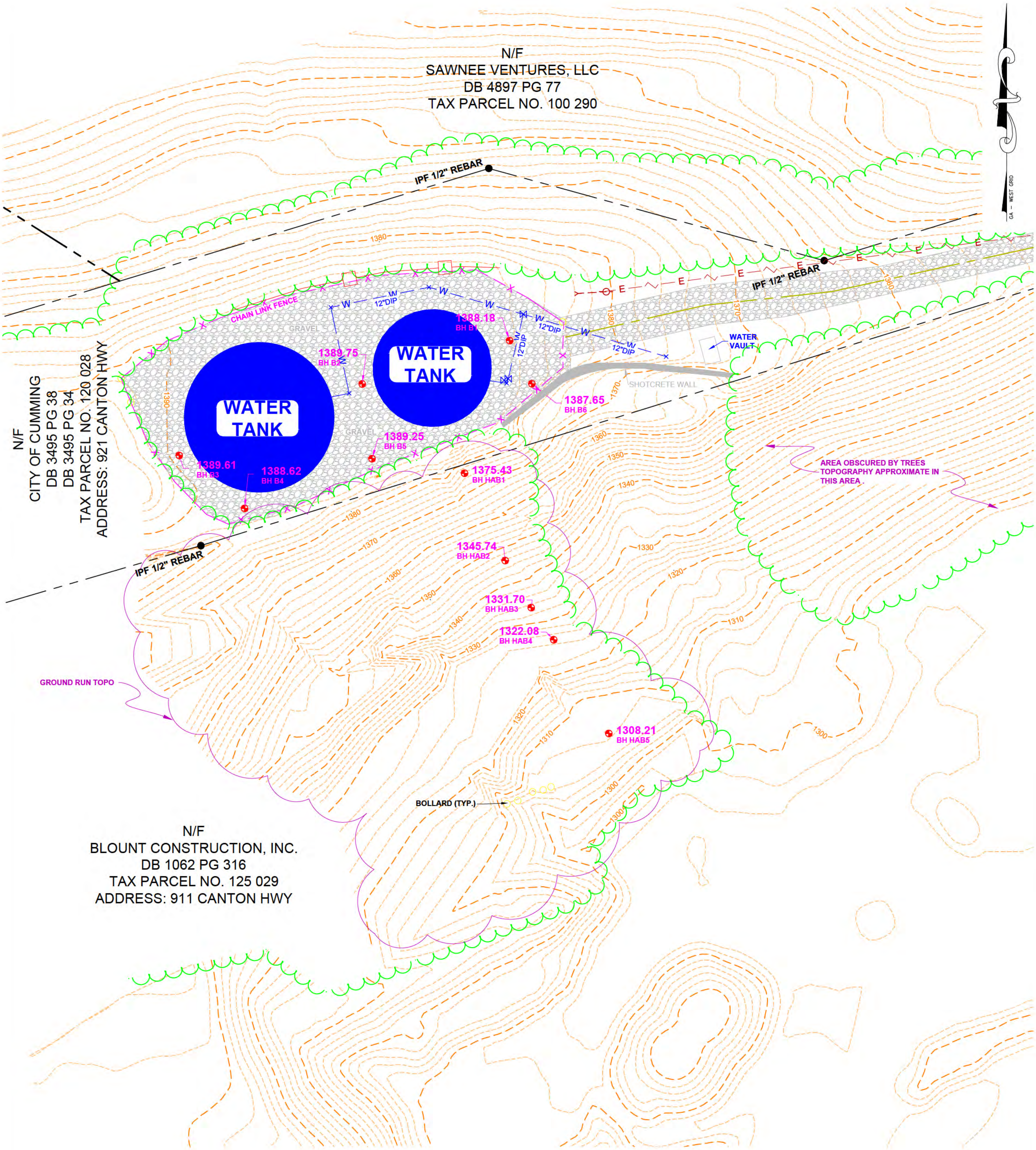
USGS - CUMMING QUADRANGLE
1964



USGS - CUMMING QUADRANGLE
1999

APPENDIX B

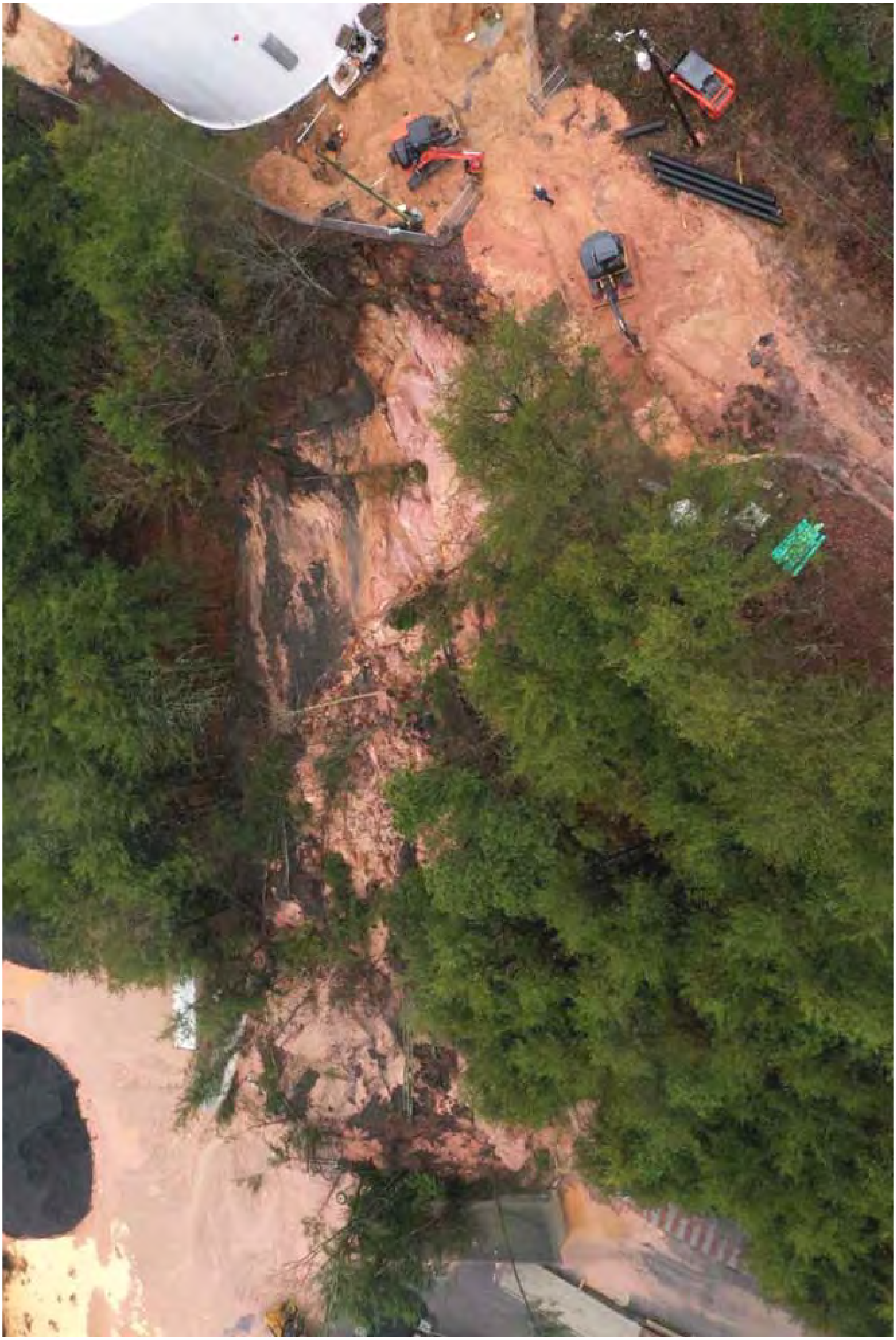
EXISTING SITE CONDITIONS DOCUMENTATION



cEc CIVIL ENGINEERING CONSULTANTS, INC. Civil & Environmental Engineering	PREPARED FOR: CITY OF CUMMING	GRAPHIC SCALE 30 0 15 30 60 1 inch = 30 ft.
	PROJECT: SAWNEE TANK EMERGENCY REPAIR	
416 PIRKLE FERRY RD., Suite K300 Cumming, GA 30040 (770) 977-5747 www.cecincga.com	SHEET NAME: TOPOGRAPHY EXHIBIT	
	DATE: 02/24/2023 SHEET 1 OF 1	

Drone Photo of Slope Failure on 12/09/2022

Drone Photo of Slope Failure on 12/09/2022



Drone Photo of Slope Failure on 12/09/2022

Slope Failure 12/08/2022

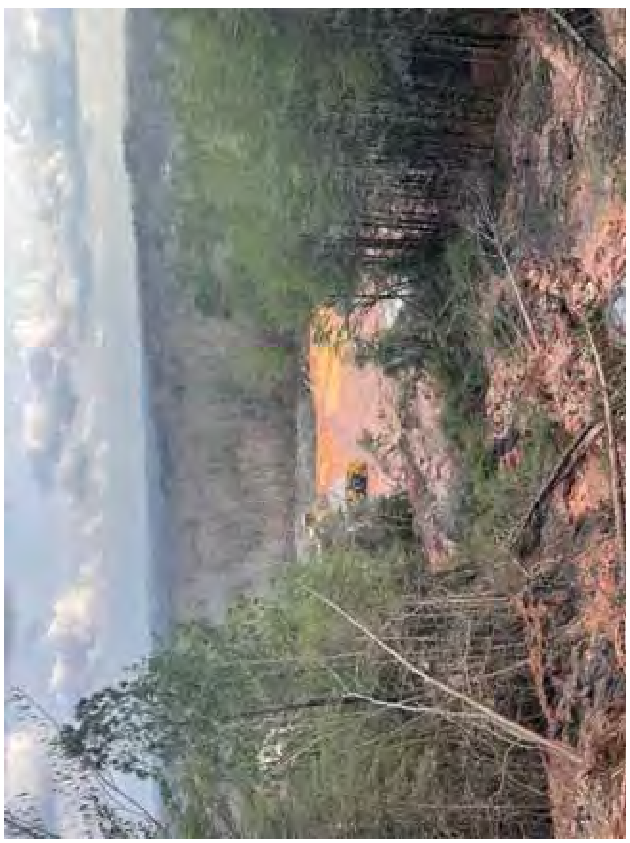
Slope Failure 12/08/2022

Slope Failure 12/08/2022

Slope Failure 12/08/2022

Slope Failure 12/08/2022

Slope Failure 12/08/2022



Slope Failure 12/08/2022

Slope Failure 12/08/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Existing Slope Conditions Southwest of Failure 12/09/2022

Cast Iron Pipes in Existing Slop Southwest of Failure 02/03/2023

Steel Beam in Existing Slope Southwest of Failure 2/03/2023

Cast Iron Pipes in Existing Slope Southwest of Failure 02/03/2023

Steel Beam in Existing Slope Southwest of Failure

Existing Slope Conditions Southwest of Failure

Existing Slope Conditions Southwest of Failure

Existing Slope Conditions Southwest of Failure

Soil Nail Wall Installed by GSI

Soil Nail Wall Installed by GSI

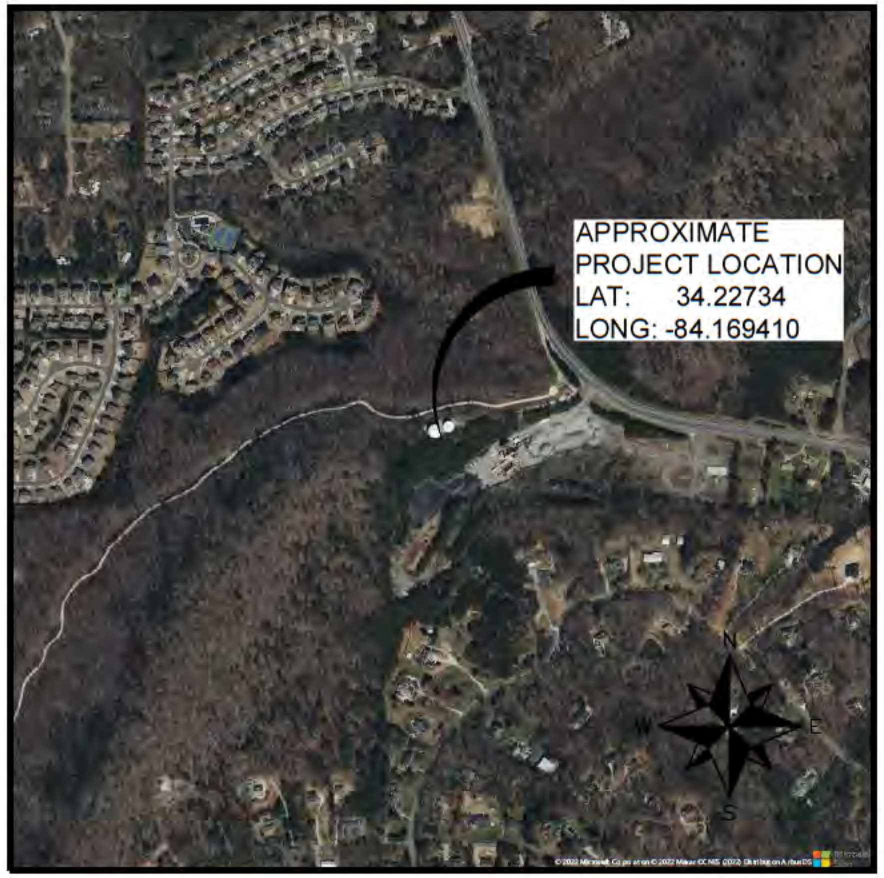
Soil Nail Wall Installed by GSI

Soil Nail Wall Installed by GSI

SLOPE STABILIZATION PLANS

921 CANTON HIGHWAY

CUMMING, GA
CITY OF CUMMING



VICINITY MAP
(NOT TO SCALE)

SHEET INDEX

SHEET REVISIONS

DATE	DESCRIPTION	NO
12/15/22	ISSUED FOR REVIEW	IFR
12/16/22	ISSUED FOR CONSTRUCTION	IFC

PROJECT NAME:
921 CANTON HIGHWAY

SHEET TITLE:
COVER SHEET

DRAWN BY:	CHECKED BY:	DATE:	PROJECT NUMBER:	SHEET
AZ	WT	12/16/2022	220665GA01	C-01

GeoStabilization International®
4475 E 74th Ave, Suite 100
Commerce City, CO 80022 USA
Phone: 855.579.0536 | Fax: 970.245.7737
www.geostabilization.com

GEORGIA REGISTERED No. PE044571 PROFESSIONAL ENGINEER WALTER TURNBULL

CONSTRUCTION SEQUENCE/WORK SCHEDULE:

THE CONTRACTOR WILL PROVIDE AND INSTALL THE SPECIFIED SOIL NAILS AND SLOPE SURFACE TREATMENT PER THE CONSTRUCTION DOCUMENTS. THE ANTICIPATED CONSTRUCTION SEQUENCE IS AS FOLLOWS:

1. DELINEATE LIMITS OF STABILIZATION. NOTIFY LOCAL UTILITIES PROVIDERS TO LOCATE AND MARK POTENTIAL UNDERGROUND FACILITIES. DAYLIGHTING OF UTILITIES IN POTENTIAL CONFLICT, AS NECESSARY. BY OTHERS
2. PREPARE THE WORK AREA FOR STABILIZATION CONSTRUCTION, BY OTHERS
   2.1. ESTABLISH TRAFFIC CONTROL, BY OTHERS.
   2.2. PREPARE SITE ACCESS, BY OTHERS.
3. EXCAVATE, REMOVE, AND DISPOSE OF SPOILS MATERIAL GENERATED DURING EXCAVATION, BY OTHERS.
4. MARK THE LOCATIONS OF THE PROPOSED SOIL NAILS WITH SURVEY MARKING PAINT.
5. INSTALLATION OF SOIL NAILS. NAILS WILL BE GROUTED DURING DRILLING UNLESS DIRECTED OTHERWISE BY GSI ENGINEER.
6. INSTALL SURFACE TREATMENT PER THE CONSTRUCTION DOCUMENTS.

HOUSE KEEPING:

- THE SITE WILL BE ORGANIZED AND CLEAR OF ANY TRASH OR DEBRIS. ALL TRASH WILL BE PLACED IN A PROPER CONTAINER AND REMOVED AT THE END OF EACH WORK DAY.

SAFETY:

- ALL SAFETY PLANS FOR LIFTING, HEARING, DUST CONTROL, PPE ETC. WILL BE IN PLACE AND FOLLOWED ACCORDINGLY. PPE INCLUDES SAFETY VEST, STEEL TOED SHOES, HARD HAT, SAFETY GLASSES, RESPIRATOR DURING DUST PRODUCING ACTIVITIES, AND GLOVES.
- ALL FIELD PERSONNEL SHALL ATTEND SITE SPECIFIC ORIENTATION PRIOR TO BEING ON SITE, AS REQUIRED.
- DAILY PRE/POST JOB BRIEFINGS WILL BE HELD AND DOCUMENTED; ALL ON SITE PERSONNEL WILL BE REQUIRED TO REVIEW AND SIGN.

EMPLOYEE CERTIFICATIONS:

- ACI SHOTCRETE NOZZLEMEN CERTIFICATION
- 10-HOUR OCCUPATIONAL SAFETY AND HEALTH TRAINING COURSE IN CONSTRUCTION SAFETY & HEALTH
- AMERICAN RED CROSS STANDARD FIRST AID TRAINING
- AMERICAN RED CROSS BLOODBORNE PATHOGENS TRAINING: PDT

SIZE AND TYPE OF NAILS:

- THE SOIL NAIL ELEMENTS SHALL CONSIST OF SELF-DRILLING SOIL NAILS.
- SACRIFICIAL DRILL BITS WILL BE ATTACHED TO THE SOIL NAIL PRIOR TO INSTALLING THE NAIL IN THE GROUND.
- SACRIFICIAL DRILL BITS ARE NOT PERMANENTLY INCORPORATED INTO THE PROJECT AND MAY BE REMOVED AFTER DRILLING OR LEFT AT THE PROJECT FOR THE CONTRACTOR'S CONVENIENCE. SACRIFICIAL DRILL BITS ARE NOT END PRODUCTS. SACRIFICIAL DRILL BITS ARE NOT PRODUCED IN THE UNITED STATES.
- GSI ENGINEER MAY ELECT TO MODIFY THE NAIL TYPE, LENGTH OR INSTALLATION METHOD, DEPENDING ON ACTUAL DRILLING CONDITIONS.

FACING AND DRAINAGE SYSTEM:

- DRAIN STRIPS WILL BE PROVIDED AND INSTALLED BETWEEN THE SOIL NAILS ALONG THE FACE OF THE EXCAVATION. THE DRAIN STRIPS SHALL BE PLACED WITH THE GEOTEXTILE SIDE AGAINST THE GROUND. DRAIN STRIPS WILL BE CONTINUOUS AND ANY SPLICES SHALL BE MADE WITH A ONE-FOOT MINIMUM OVERLAP SUCH THAT THE FLOW OF WATER IS NOT IMPEDED. DRAIN STRIPS SHALL EXTEND BEYOND THE FACE OF THE SHOTCRETE AT THE DOWNHILL FACE.
- DRAIN STRIPS SHALL BE MINIMUM 12" WIDE.

REINFORCING STEEL PLACEMENT:

- WELDED WIRE MESH WILL BE PLACED ALONG THE FACE OF THE EXCAVATION WITH A SEPARATION BETWEEN THE WIRE MESH AND THE SOIL AS CALLED OUT IN THE DETAILS.
- NO. 4 REBAR WILL BE TIED TO THE WIRE MESH. VERTICAL BARS WILL EXTEND FOR APPROXIMATELY 36" AND THE HORIZONTAL BARS WILL BE CONTINUOUS (WITH A MINIMUM OF 24" OVERLAP SPLICES) IN THE SHOTCRETE.

BEARING PLATE PLACEMENT:

- STEEL BEARING PLATES WILL BE PLACED OVER THE NAILS AND ATTACHED WITH A HEX NUT TO SECURE THE WIRE MESH AND REBAR DURING SHOTCRETE PLACEMENT. IF THE SOIL NAILS EXTEND BEYOND THE HEX NUTS OR WELDED PLATES, THEY WILL BE TRIMMED.

SHOTCRETE APPLICATION:

- SHOTCRETE WILL BE PLACED FROM THE LOWER PART OF THE AREA UPWARDS TO PREVENT ACCUMULATION OF REBOUND. THE NOZZLE WILL BE ORIENTED A PROPER DISTANCE FROM AND APPROXIMATELY PERPENDICULAR TO THE WORKING FACE SO THAT REBOUND WILL BE MINIMAL AND COMPACTION WILL BE MAXIMIZED. CARE WILL BE TAKEN WHILE ENCASING REINFORCING STEEL AND MESH TO KEEP THE FRONT FACE OF THE REINFORCEMENT CLEAN DURING PLACEMENT OPERATIONS, SO THAT SHOTCRETE BUILDS UP FROM BEHIND, TO ENCASE THE REINFORCEMENT AND PREVENT VOIDS OR POCKETS FROM FORMING.

GROUT MIX DESIGN:

- DESIGN 28 DAY COMPRESSIVE STRENGTH = 3,000 PSI
- GROUT SLURRY SHALL CONSIST OF A NEAT CEMENT MIXTURE OF CLEAN WATER AND PORTLAND CEMENT. NO ADDITIONAL ADMIXTURES SHALL BE USED UNLESS APPROVED BY GSI ENGINEER.
- THE W/C SHALL RANGE BETWEEN 0.5 AND 0.6 AS DETERMINED BY A MUD BALANCE SP. GR. VALUE BETWEEN 1.83 AND 1.74.

SHOTCRETE MIX DESIGN:

- SHOTCRETE SHALL COMPLY WITH THE REQUIREMENTS OF ACI 506.2, "SPECIFICATIONS FOR MATERIALS, PROPORTIONING AND APPLICATION OF SHOTCRETE", EXCEPT AS OTHERWISE SPECIFIED. SHOTCRETING CONSISTS OF APPLYING ONE OR MORE LAYERS OF CONCRETE CONVEYED THROUGH A HOSE PNEUMATICALLY PROJECTED AT A HIGH VELOCITY AGAINST A PREPARED SURFACE.
- THE WET-MIX PROCESS CONSISTS OF THOROUGHLY MIXING ALL THE INGREDIENTS, INTRODUCING THE MIXTURE INTO THE DELIVERY EQUIPMENT AND DELIVERING IT, BY POSITIVE DISPLACEMENT, TO THE NOZZLE. AIR JET THE WET-MIX SHOTCRETE FROM THE NOZZLE AT HIGH VELOCITY ONTO THE SURFACE.
- GSI STANDARD SHOTCRETE MIX DESIGN SHALL BE USED UNLESS SHOTCRETE TEMPERATURES ARE ANTICIPATED TO REACH AND/OR EXCEED 85°F. IN THIS EVENT, GSI HOT WEATHER MIX MAY BE USED. SET TIME CONTROLLING ADDITIVES (I.E. HYDRATION STABILIZERS, RETARDERS) MAY BE USED PER THE MANUFACTURER SPECIFICATIONS AND UNDER THE DIRECTION OF A GSI ENGINEER.

GSI STANDARD SHOTCRETE MIX DESIGN:

MATERIAL	WEIGHT PER CUBIC YARD
3/8" ROCK	650 LBS
SAND	1800 LBS
CEMENT	750 LBS
WATER	300 LBS
FLY ASH	150 LBS
AIR ENTRAINMENT	6% (1.6 FT^3)

0.40 TO 0.50 WATER/CEMENT RATIO

GSI HOT WEATHER SHOTCRETE MIX DESIGN:

MATERIAL	WEIGHT PER CUBIC YARD
3/8" ROCK	600 LBS
SAND	1,800 LBS
CEMENT	700 LBS
WATER	315 LBS
FLY ASH	300 LBS
AIR ENTRAINMENT	6% (1.6 FT^3)

0.40 TO 0.50 WATER/CEMENT RATIO

SHEET REVISIONS

DATE	DESCRIPTION	NO
12/15/22	ISSUED FOR REVIEW	IFR
12/16/22	ISSUED FOR CONSTRUCTION	IFC

PROJECT NAME: 921 CANTON HIGHWAY

SHEET TITLE: GENERAL NOTES

DRAWN BY:	CHECKED BY:	DATE:	PROJECT NUMBER:	SHEET
AZ	WT	12/16/2022	220665GA01	C-02

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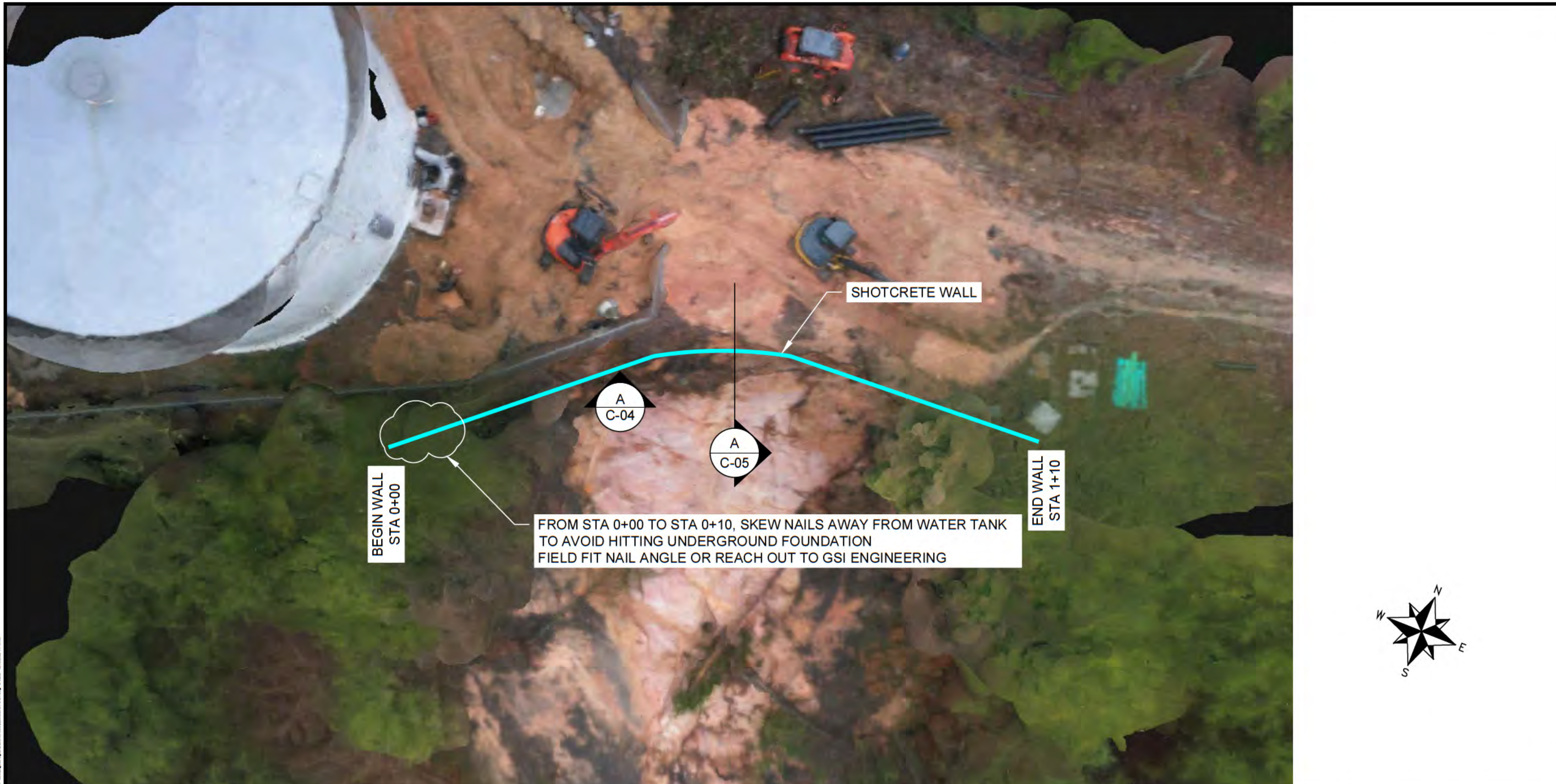
www.geostabilization.com

GEORGIA REGISTERED No. PE044571 PROFESSIONAL ENGINEER WALTER TURNBULL



SHEET REVISIONS

DATE	DESCRIPTION	NO
12/15/22	ISSUED FOR REVIEW	IFR
12/16/22	ISSUED FOR CONSTRUCTION	IFC

PROJECT NAME:

921 CANTON HIGHWAY

SHEET TITLE:

SITE PLAN

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AZ	WT	12/16/2022	220665GA01	C-03

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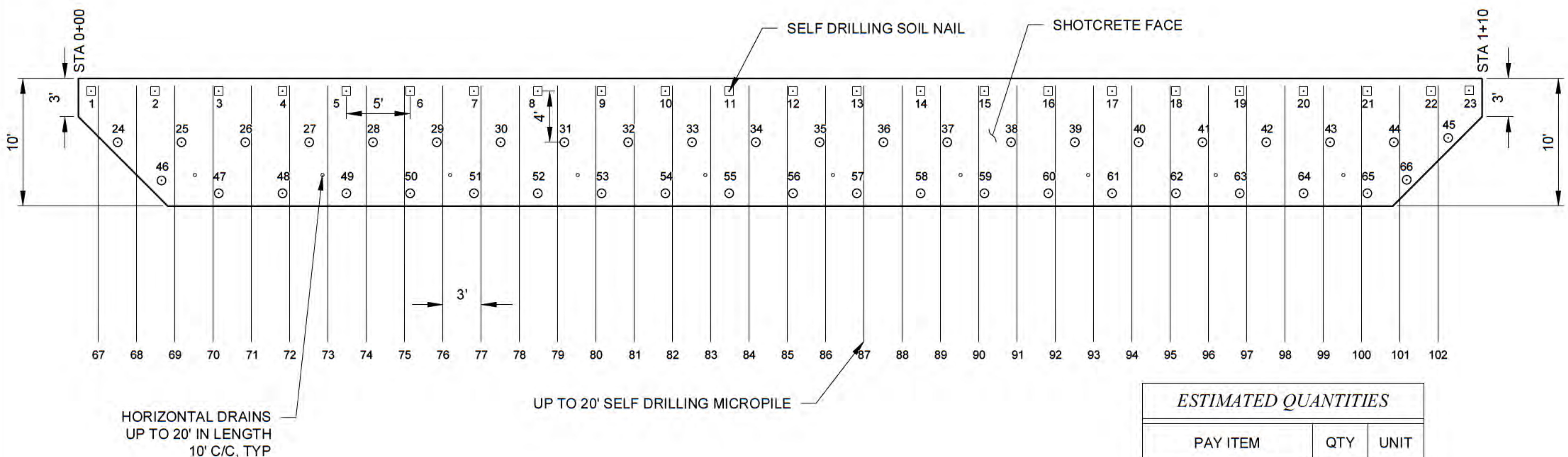
NOTES:

- DRAIN STRIPS NOT SHOWN FOR CLARITY.
- INSTALL DRAIN STRIPS EVERY 5'.



A TYPICAL PROFILE

SCALE: 1" = 8'

ESTIMATED QUANTITIES

PAY ITEM	QTY	UNIT
UP TO 30' SOIL NAILS ⊡	23	EA
UP TO 20' SOIL NAILS ⊙	43	EA
UP TO 20' MICROPILES	36	EA
10" SHOTCRETE (TOP 4')	440	SF
8" SHOTCRETE (BOTTOM 6')	612	SF
20' HORIZONTAL DRAINS ∘	10	EA
K-WALL SHOULDER BUILD-UP	110	LF

SHEET REVISIONS

DATE	DESCRIPTION	NO
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12/16/22	ISSUED FOR CONSTRUCTION	IFC

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PROJECT NAME:

921 CANTON HIGHWAY

SHEET TITLE:

PROFILE VIEW

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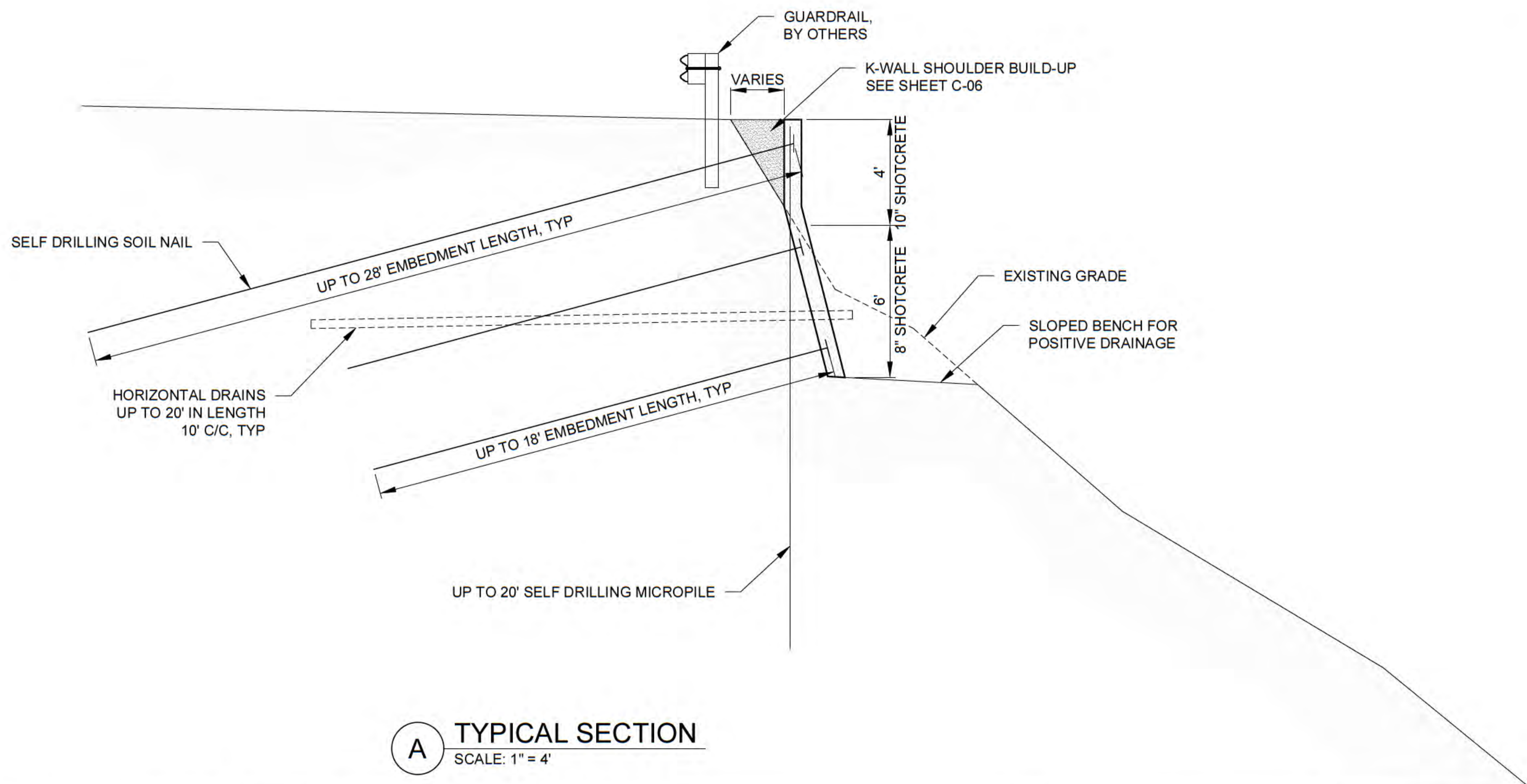

A TYPICAL SECTION

SCALE: 1" = 4'

SHEET REVISIONS

DATE	DESCRIPTION	NO
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12/16/22	ISSUED FOR CONSTRUCTION	IFC

PROJECT NAME:

921 CANTON HIGHWAY

SHEET TITLE:

SECTION VIEW

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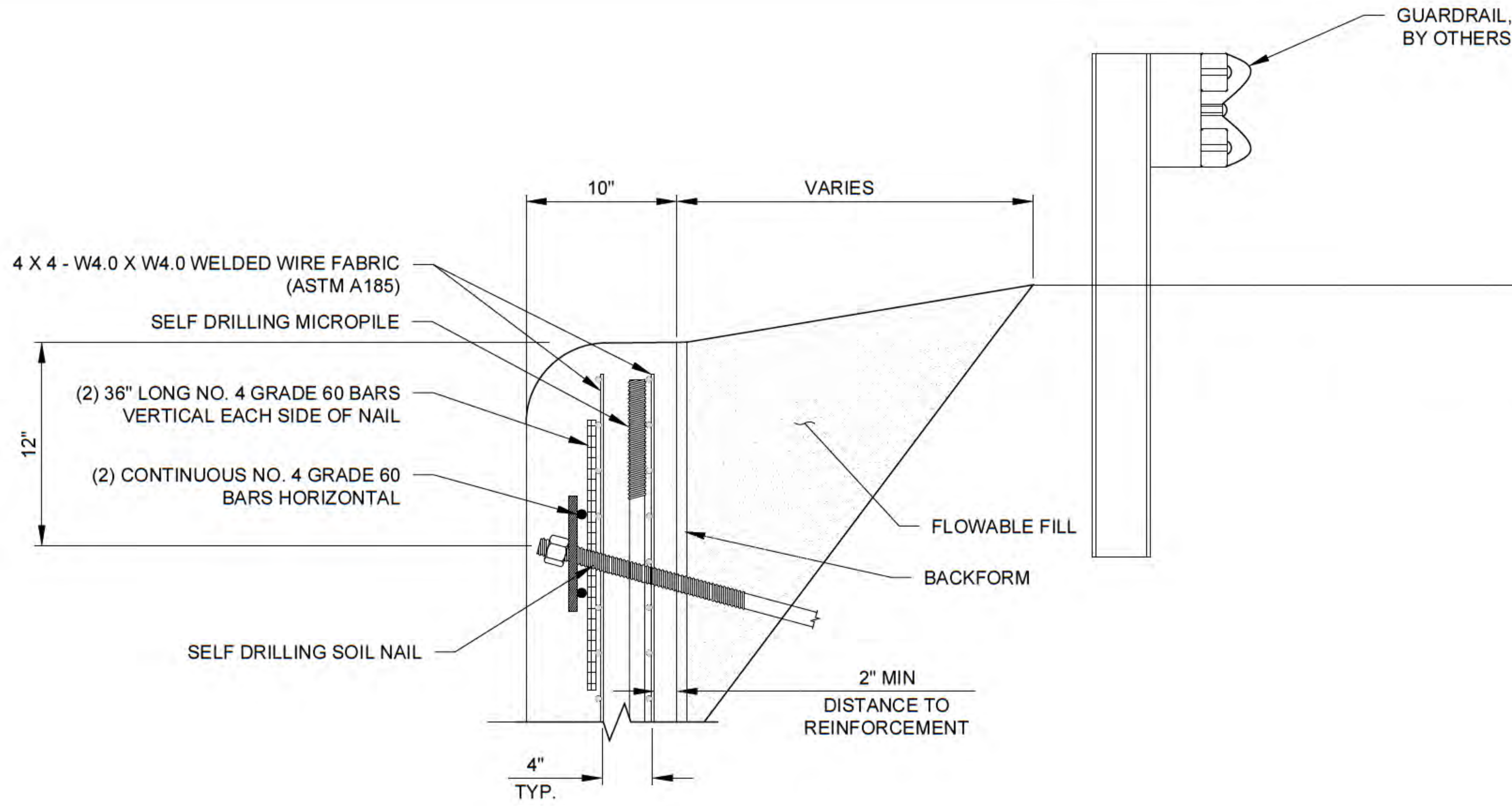

A STANDARD DETAIL
N.T.S.

SHEET REVISIONS

DATE	DESCRIPTION	NO
12/15/22	ISSUED FOR REVIEW	IFR
12/16/22	ISSUED FOR CONSTRUCTION	IFC

PROJECT NAME:
921 CANTON HIGHWAY

SHEET TITLE:
STANDARD DETAILS

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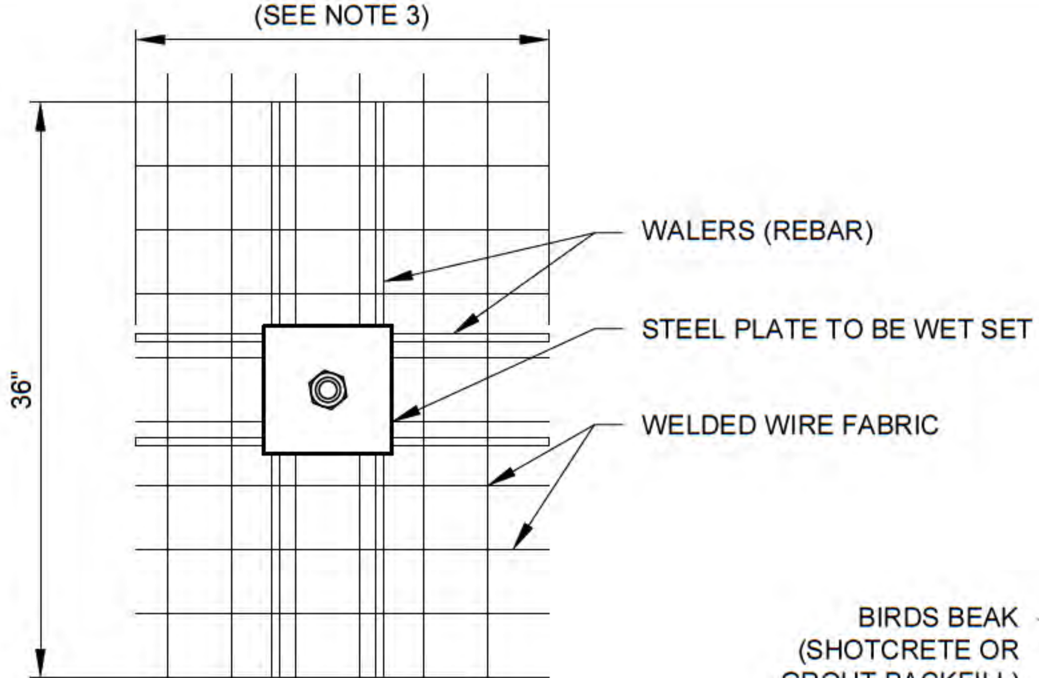
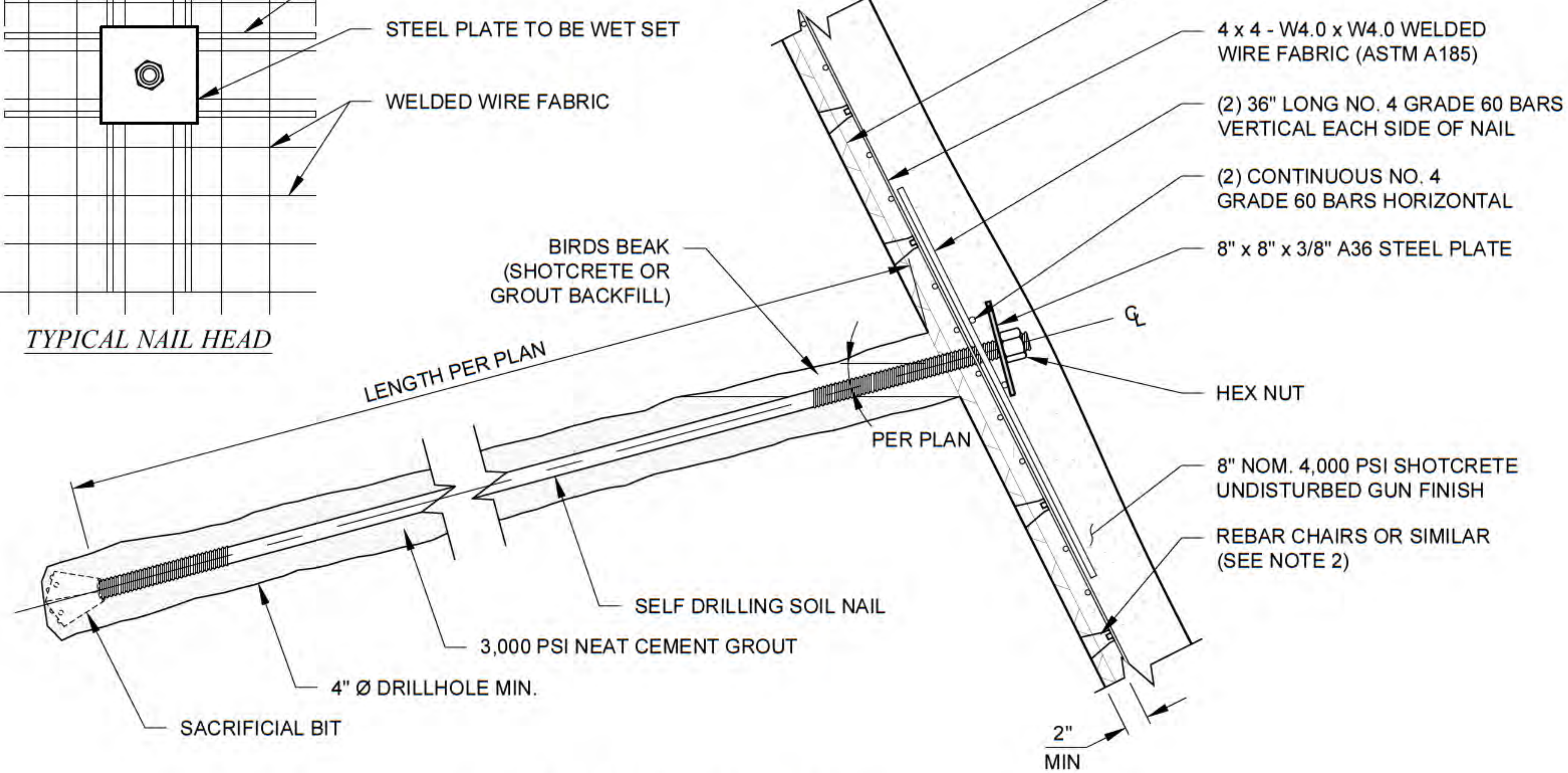


TYPICAL NAIL HEAD



A STANDARD DETAIL
N.T.S.

NOTES:

1. WELDED WIRE FABRIC TO HAVE A MINIMUM OF 8" OVERLAP (2 SQUARES OVERLAP FOR 4 x 4 MESH).
2. REBAR CHAIRS OR EQUIVALENT TO BE USED TO ENSURE SUFFICIENT CONCRETE COVER BETWEEN GROUND SURFACE AND REINFORCEMENT. 2 TO 3 DOBIES PER 5' x 10' SHEET OF MESH, TYPICAL.
3. HORIZONTAL WALERS ARE CONTINUOUS

SHEET REVISIONS

DATE	DESCRIPTION	NO
12/15/22	ISSUED FOR REVIEW	IFR
12/16/22	ISSUED FOR CONSTRUCTION	IFC

PROJECT NAME:
921 CANTON HIGHWAY

SHEET TITLE:
STANDARD DETAILS

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APPENDIX C

FIELD AND LABORATORY PROCEDURES

GEOSYSTEMS ENGINEERING

STANDARD FIELD AND LABORATORY TESTING PROCEDURES

Soil Test Boring

Soil sampling and penetration testing are performed in general accordance with ASTM Designation D 1586. Borings are usually advanced either by mechanically twisting continuous steel hollow-stem auger flights into the ground or by wash boring using roller cone or Hawthorne bits. At regular intervals, soil samples are obtained with a standard 1.4-inch I.D., 2-inch O.D., split-spoon sampler. The sampler is first seated 6 inches into the bottom of the hole to penetrate any loose cuttings and then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to achieve the final foot of penetration is recorded and is designated the "standard penetration resistance." Penetration resistance, when properly evaluated, is an index to the soil strength, density and ability to support foundations.

Groundwater levels are normally determined by the driller in conjunction with the field investigation and are noted on the drilling records. These levels indicate the approximate location of the hydrostatic water table at the time of observation. Generally, water levels are reported at the time of boring and at subsequent times. The time of boring water level is detected as the drilling tools are advanced by changes in the drilling rate, soil sample moisture conditions, water or mud on the drill rods, and moisture conditions of the borehole drill cuttings. Additional groundwater levels are typically obtained at various times after boring to minimize any disruption by the drilling operations and to allow the water table to stabilize. Normally, a time lag of at least 24 hours is required to permit stabilization of the water table. A longer time period may be required in low permeability (clayey) soils. Water table measurements are taken in open boreholes using a weighted measuring tape or electronic groundwater level indicator.

Representative portions of the soil samples, obtained from the split-spoon sampler, are sealed in containers and shipped or transported to the office. In the office, the samples are examined by an engineer to verify the driller's field classifications.

Undisturbed Sampling

Split tube samples are suitable for visual examination and classification tests but are not sufficiently intact for quantitative laboratory testing. Relatively undisturbed samples are obtained by pushing sections of 3 inch O.D., 16-gauge, steel "Shelby" tubing into the soil at the desired sampling levels. This procedure is described by ASTM Standard D-1587. Each tube, together with the encased soil, is carefully removed from the ground, made airtight, and transported to the laboratory. Locations and depths of undisturbed samples are shown on the Test Pit or Boring Records.

Soil Identification and Description

Soils are normally classified using the Unified Soil Classification System (ASTM D 2487). In addition to standard classification, soils are identified in accordance with the important soil properties to provide a complete description and assist with predicting behavior. Soil properties significant to most earthwork/foundation problems include consistency (cohesive fine grained soils) or relative density (cohesionless granular soils), color, and texture or composition. Consistency and relative density are fundamental properties in evaluating soil strength and are typically estimated based on standard penetration test results. The engineer's examination of soil samples recovered during the field investigation is primarily a qualitative visual process. Detailed soil classification requires basic laboratory grain size analyses and Atterberg limits (plasticity) tests.

Physical Properties

In-situ physical soil properties are described by the specific gravity, wet unit weight, moisture content, dry unit weight, void ratio, and percent saturation. Specific gravity is the ratio of the unit weight of the soil solids to the unit weight of distilled water at 4 degrees C. Moisture content of soil is defined as the weight of water in a given soil mass divided by the weight of dry soil solids in the same mass. Specific gravity and moisture content are determined in accordance with ASTM Standards D-854 and D-2216, respectively. Wet unit weight is obtained by weighing a known volume of soil and dividing the weight by the known volume. Dry unit weight is calculated from the wet weight, once the moisture content of the sample is determined. Void ratio, the ratio of the volume of voids to the volume of solids in a given volume of soil, and percent saturation, the ratio of the volume of water to the total volume of soil voids, are calculated from the measured weight/volume relationships for a given soil mass.

Grain Size/Gradation

Grain size tests are performed to determine the soil classification and the grain size distribution. The soil samples are prepared for testing according to ASTM D-421 (dry preparation) or ASTM D-2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. A sample of known weight is passed through the sequence of sieves with decreasing size of openings and the portions retained on each sieve weighed. Materials passing the number 200 sieve are suspended in water and the grain size distributing calculated from the measured settlement rate (hydrometer analysis). Hydrometer analysis determines the density of a suspension of soil at various times after agitation. Using Stokes's law, the particle size remaining suspended at each particular time is calculated and the corresponding density is a measure of the quantity of soil smaller than the computed size. Procedures for the quantitative determination of the distribution of particle (grain) sizes in soils is described by ASTM D-422. Determination of the total amount of material finer than the No. 200 sieve is in accordance with ASTM D-1140.

Soil Plasticity

Representative samples of the soils were selected for Atterberg limits testing to determine the soil plasticity characteristics. The soil's Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The LL is the moisture content at which the soil will flow as a heavy viscous fluid, and the PL is the moisture content at which the soil begins to lose its plasticity. The soil plasticity characteristics are determined in accordance with ASTM D-4318.

Certain soils swell and shrink with increases and decreases in soil moisture. The PL is related to this potential volume change ability. When such volume changes occur in soils confined beneath foundations, structural deformations can be produced. Past experience has shown that soils having a PI of less than 30 are only slightly susceptible to volume changes. Soils having a PI greater than 50 are generally very susceptible to these volume changes. Soils with a PI between these limits have moderate volume change potential.

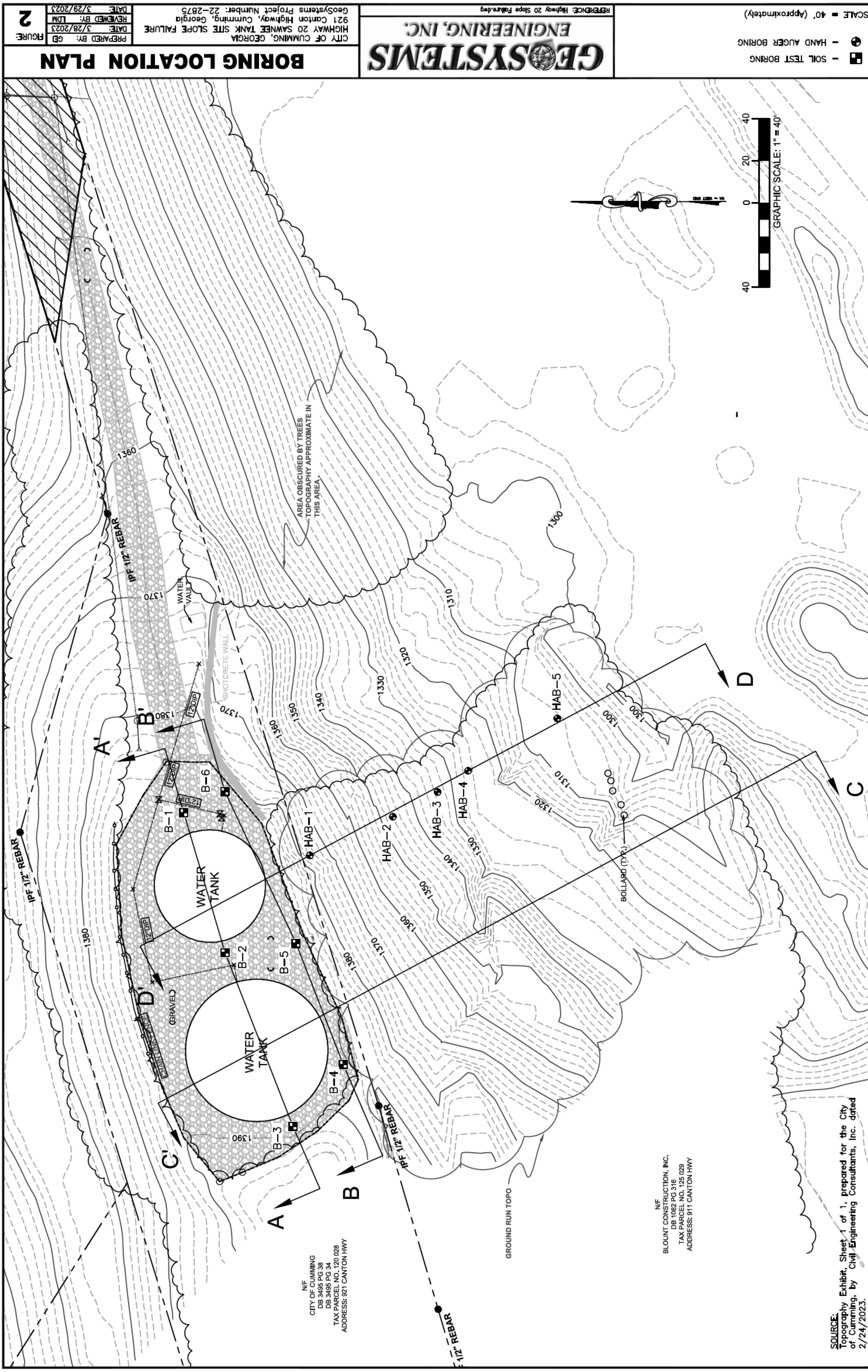
Triaxial Shear Test

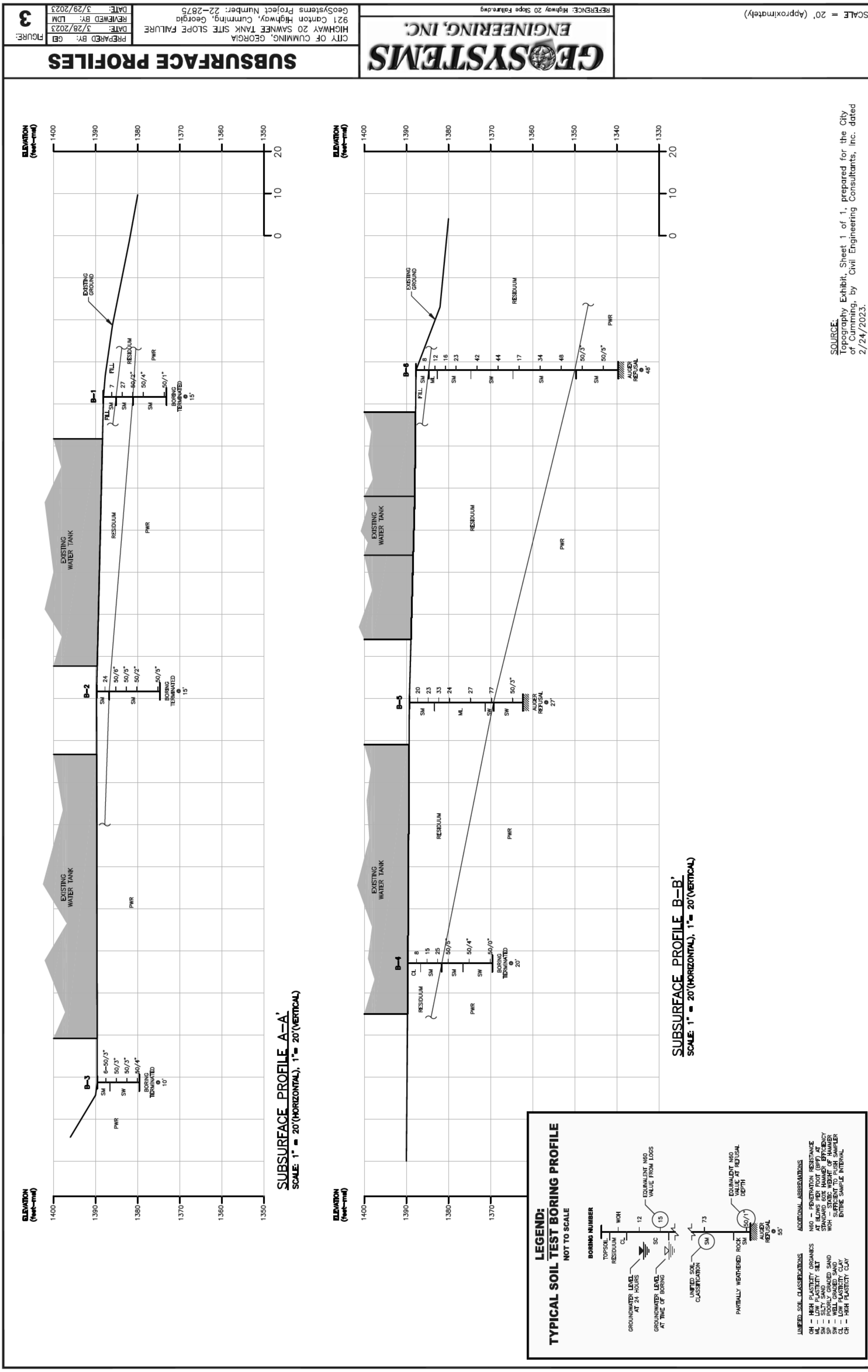
Drained and undrained strength parameters for soils are usually obtained by triaxial shear testing, where the test specimen drainage can be controlled and the pore pressure measured. There are three common types of triaxial shear tests: (1) UU - Unconsolidated Undrained or "Quick" test, (2) CU - Consolidated Undrained and (3) CD - Consolidated Drained. Triaxial shear tests make possible the determination of both total (c) and (ϕ), and effective (c') and (ϕ') cohesion and angle of friction soil strength parameters. The following are the ASTM test procedures for these tests: (1) ASTM D2850 - Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils, (2) ASTM D4767 - Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils and (3) ASTM D7181 - Standard Test Method for Consolidated Drained Triaxial Compression Test for Soils.

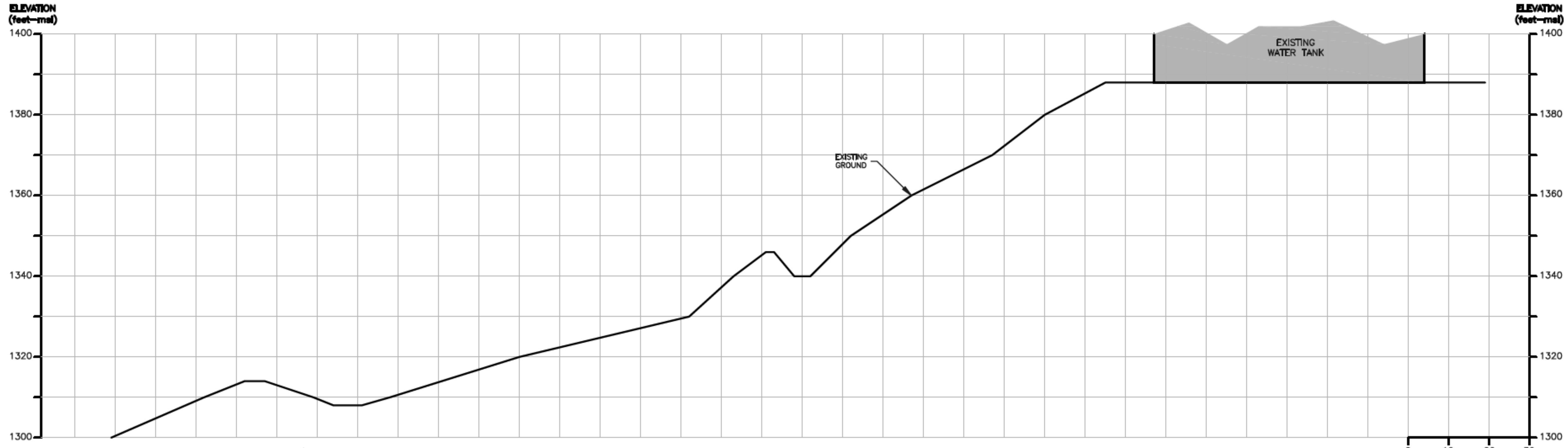
A complete triaxial test usually consists of shearing three specimens of a single soil sample at different confining pressures to determine the shear strength. Each specimen is prepared for testing by trimming into a nominal 3-inch diameter cylinder with a height to diameter ratio of 2:1, encased in a rubber membrane and placed in a compression chamber. The specimen is initially saturated for effective stress tests (CU and CD) to assure reliable measurements of the pore water pressures. After saturation, the test specimen is then subjected to an all-around confining pressure and consolidated to a stress condition representative of the in-situ soil condition. During the final stage of testing, the axial load on the test specimen is gradually increased until the specimen fails in shear. The test results are presented in the form of stress-strain curves and Mohr circle envelopes.

APPENDIX D

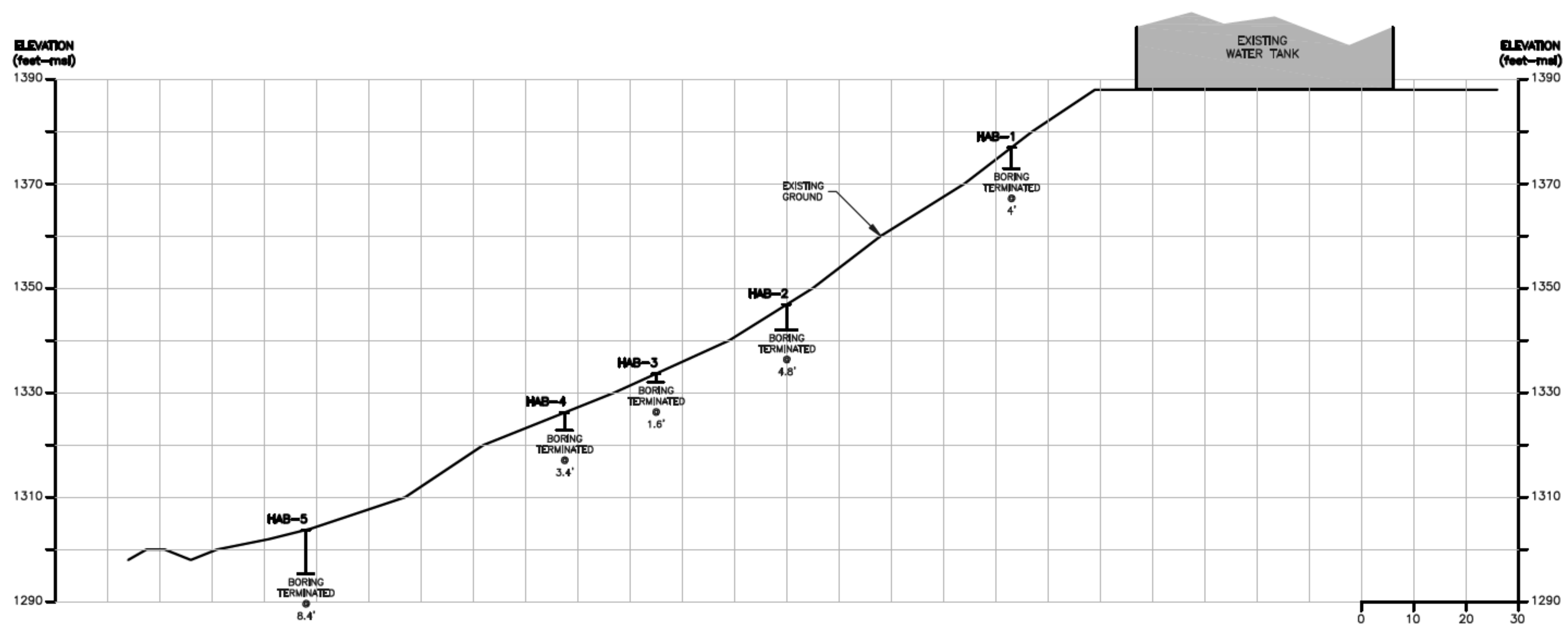
FIGURE 2 – BORING LOCATION PLAN
FIGURE 3 – SUBSURFACE SECTIONS (A-A' & B-B')
FIGURE 4 – SUBSURFACE SECTIONS (C-C' & D-D')
KEY TO SYMBOLS AND CLASSIFICATIONS
SOIL TEST BORING LOGS (6)
HANDAUGER BORING SUMMARY


BORING LOCATION PLAN
CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
921 Canton Highway, Cumming, Georgia
GeoSystems Project Number: 22-2875
PREPARED BY: GEI DATE: 3/28/2023
REVIEWED BY: LDM DATE: 3/29/2023
FIGURE: 2
GEOSYSTEMS ENGINEERING, INC.
REFERENCE: Highway 20 Slope Failure.dwg
SCALE = 40' (Approximately)
HAND AUGER BORING
SOIL TEST BORING
GRAPHIC SCALE: 1" = 40'
AREA OBSCURED BY TREES TOPOGRAPHY APPROXIMATE IN THIS AREA.
WATER VAULT
SHOTCRETE WALL
WATER TANK
WATER TANK
(GRAVEL)
B-1
B-2
B-3
B-4
B-5
B-6
HAB-1
HAB-2
HAB-3
HAB-4
HAB-5
BOLLARD (TYP.)
IPF 1/2" REBAR
GROUND RUN TOPO
N/F CITY OF CUMMING DB 3495 PG 38 DB 3495 PG 34 TAX PARCEL NO. 120 028 ADDRESS: 921 CANTON HWY
N/F BLOUNT CONSTRUCTION, INC. DB 1062 PG 316 TAX PARCEL NO. 125 029 ADDRESS: 911 CANTON HWY
SOURCE: Topography Exhibit, Sheet 1 of 1, prepared for the City of Cumming, by Civil Engineering Consultants, Inc. dated 2/24/2023.

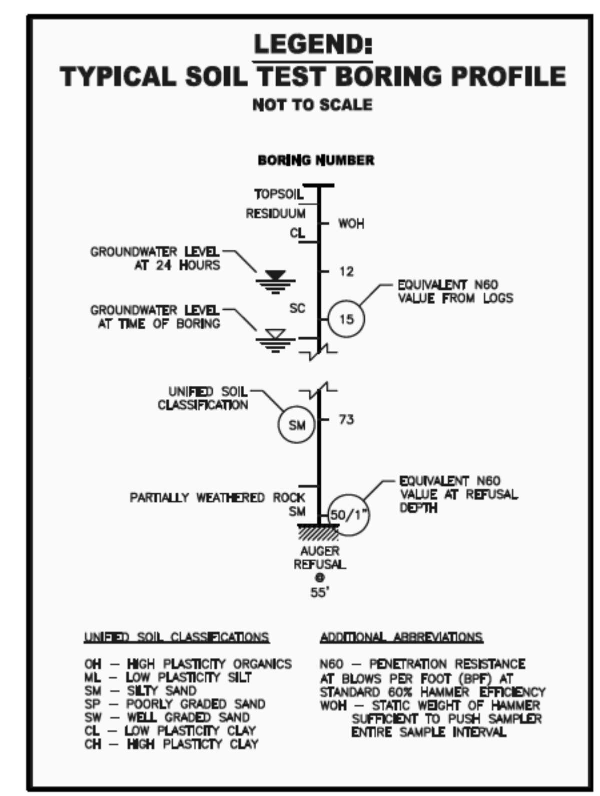

SUBSURFACE PROFILES
GEOSYSTEMS ENGINEERING, INC.
CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
921 Canton Highway, Cumming, Georgia
GeoSystems Project Number: 22-2875
REFERENCE: Highway 20 Slope Failure.dwg
FIGURE: 3
PREPARED BY: GEI
DATE: 3/28/2023
REVIEWED BY: LDM
DATE: 3/29/2023
SCALE = 20' (Approximately)
SUBSURFACE PROFILE A-A'
SCALE: 1" = 20'(HORIZONTAL), 1"= 20'(VERTICAL)
SUBSURFACE PROFILE B-B'
SCALE: 1" = 20'(HORIZONTAL), 1"= 20'(VERTICAL)
ELEVATION (feet-msl)
EXISTING GROUND
EXISTING WATER TANK
RESIDUUM
PWR
FILL
B-1
B-2
B-3
B-4
B-5
B-6
BORING TERMINATED
AUGER REFUSAL
SOURCE:
Topography Exhibit, Sheet 1 of 1, prepared for the City of Cumming, by Civil Engineering Consultants, Inc. dated 2/24/2023.
LEGEND:
TYPICAL SOIL TEST BORING PROFILE
NOT TO SCALE
BORING NUMBER
TOPSOIL
RESIDUUM
GROUNDWATER LEVEL AT 24 HOURS
GROUNDWATER LEVEL AT TIME OF BORING
EQUIVALENT N60 VALUE FROM LOGS
UNIFIED SOIL CLASSIFICATION
PARTIALLY WEATHERED ROCK
EQUIVALENT N60 VALUE AT REFUSAL DEPTH
UNIFIED SOIL CLASSIFICATIONS
OH - HIGH PLASTICITY ORGANICS
ML - LOW PLASTICITY SILT
SM - SILTY SAND
SP - POORLY GRADED SAND
SW - WELL GRADED SAND
CL - LOW PLASTICITY CLAY
CH - HIGH PLASTICITY CLAY
ADDITIONAL ABBREVIATIONS
N60 - PENETRATION RESISTANCE AT BLOWS PER FOOT (BPF) AT STANDARD 60% HAMMER EFFICIENCY
WOH - STATIC WEIGHT OF HAMMER SUFFICIENT TO PUSH SAMPLER ENTIRE SAMPLE INTERVAL



SUBSURFACE PROFILE C–C'
SCALE: 1" = 30'(HORIZONTAL), 1"= 30'(VERTICAL)



SUBSURFACE PROFILE D–D'
SCALE: 1" = 30'(HORIZONTAL), 1"=30'(VERTICAL)



SOURCE:
Topography Exhibit, Sheet 1 of 1, prepared for the City of Cumming, by Civil Engineering Consultants, Inc. dated 2/24/2023.

SUBSURFACE PROFILES

CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
921 Canton Highway, Cumming, Georgia
GeoSystems Project Number: 22-2875

PREPARED BY:	GEI
DATE:	3/28/2023
REVIEWED BY:	LDM
DATE:	3/29/2023

FIGURE: 4

GEOSYSTEMS ENGINEERING, INC.

REFERENCE: Highway 20 Slope Failure.dwg

SCALE = 30' (Approximately)

KEYS TO SYMBOLS AND CLASSIFICATIONS

SPECIAL STRATIGRAPHY IDENTIFIERS USED TO HIGHLIGHT SPECIFIC LAYERS		FILL TOPSOIL PAVEMENT	PARTIALLY WEATHERED ROCK ROCK (GENERAL) WATER ALLUVIUM
COARSE GRAINED SOIL - GRAVELS & SANDS (MORE THAN 50% OF MATERIAL IS RETAINED ON NO. 200 SIEVE)	CLEAN SANDS & GRAVELS (< 5% FINES CONTENT)		SP: Poorly graded sands SW: Well graded sands GP: Poorly graded gravels GW: Well graded gravels
	SANDS & GRAVELS WITH HIGH FINES CONTENT (> 15% FINES CONTENT)		SM: Silty sands GM: Silty gravels SC: Clayey sands GC: Clayey gravels
FINE GRAINED SOIL - SILTS & CLAYS (MORE THAN 50% OF MATERIAL PASSES NO. 200 SEIVE)	SILTS		ML: Low plasticity inorganic silts MH: High plasticity inorganic silts
	CLAYS		CL: Low placticity inorganic clays CH: High plasticity inorganic clays
	ORGANIC SILTS & CLAYS		OL: Low plasticity organic silts and clays OH: High plasticity organic silts and clays

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	NUMBER OF BLOWS, N	APPROXIMATE RELATIVE DENSITY
SANDS AND GRAVELS	0 - 4	Very Loose
	5 - 10	Loose
	11 - 30	Medium Dense
	31 - 50	Dense
	OVER 50	Very Dense
	NUMBER OF BLOWS, N	APPROXIMATE RELATIVE CONSISTENCY
SILTS AND CLAYS	0 - 1	Very Soft
	2 - 4	Soft
	5 - 8	Firm
	9 - 15	Stiff
	16 - 30	Very Stiff
	31 - 50	Hard
	OVER 50	Very Hard

Key_2019.dwg

GeoSystems Engineering, Inc.

CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
FORSYTH COUNTY, GEORGIA

LOG OF BORING B-1

GEOLOGIST: *NA*	ELEVATION (feet): *1388*	NOTES: 1. No groundwater encountered at the time of drilling (NGWE). 2. No ground water measured at the end of day (NGWM).
DATE DRILLED: *12/29/2022*	BORING DEPTH (feet): *15*	
DRILLER: *KILMAN BROS., INC.*	WATER LEVEL ▽ TOB (feet): *NGWE* ▼ 24HR (feet): *NGWM*	
DRILLING METHOD: *HOLLOW STEM AUGER WTIH AUTOMATIC HAMMER*		

DEPTH (feet)	GEOLOGIC DESCRIPTION	ELEV (feet)	N VALUE
0	POSSIBLE FILL: Loose tan brown silty fine to coarse SAND (SM), rock fragments, moist	1388	7
	RESIDUUM: Medium dense tan pinkish brown silty fine to medium SAND (SM)		
5		1383	27
	PARTIALLY WEATHERED ROCK: Sampled as very dense tan white slightly micaceous silty fine to coarse SAND (SM), rock fragments		50/2"
10		1378	50/4"
15		1373	50/1"
	Boring terminated at 15 feet.		

STANDARD PENETRATION RESISTANCE (blows/ft)

2 3 4 5 6 10 20 30 40 60 80

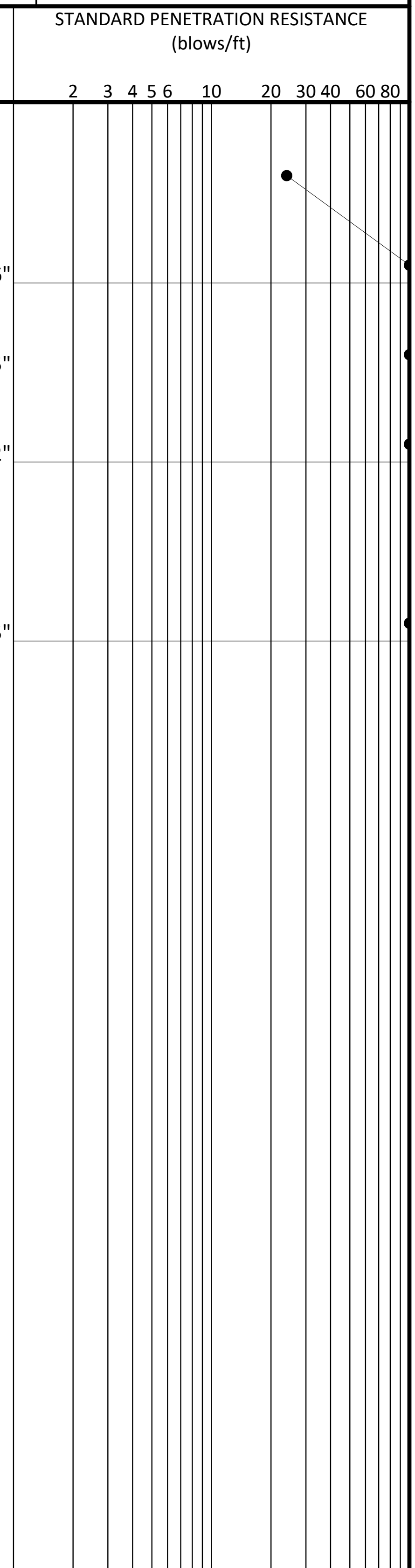
CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
FORSYTH COUNTY, GEORGIA

LOG OF BORING B-2

GEOLOGIST: *NA*	ELEVATION (feet): *1390*
DATE DRILLED: *12/28/2022*	BORING DEPTH (feet): *15*
DRILLER: *KILMAN BROS., INC.*	WATER LEVEL ▽ TOB (feet): *NGWE* ▼ 24HR (feet): *NGWM*
DRILLING METHOD: *HOLLOW STEM AUGER WTIH AUTOMATIC HAMMER*	

NOTES: 1. No groundwater encountered at the time of drilling (NGWE). 2. No ground water measured at the end of day (NGWM).

DEPTH (feet)	GEOLOGIC DESCRIPTION	ELEV (feet)	N VALUE
0	RESIDUUM: Medium dense tan brown silty fine to medium SAND (SM)	1390	24
	PARTIALLY WEATHERED ROCK: Sampled as very dense tan white silty fine to coarse SAND (SM), rock fragments		
5		1385	50/6"
	Very dense tan white silty fine to medium SAND (SM), rock fragments		50/5"
10		1380	50/2"
15		1375	50/5"
	Boring terminated at 15 feet.		



GEOSYSTEMS ENGINEERING, INC.

JOB NO. 22-2875

CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
FORSYTH COUNTY, GEORGIA

LOG OF BORING B-3

GEOLOGIST: *NA*	ELEVATION (feet): *1390*
DATE DRILLED: *12/29/2022*	BORING DEPTH (feet): *10*
DRILLER: *KILMAN BROS., INC.*	WATER LEVEL ∇ TOB (feet): *NGWE* ▼ 24HR (feet): *NGWM*
DRILLING METHOD: *HOLLOW STEM AUGER WTIH AUTOMATIC HAMMER*	

NOTES: 1. No groundwater encountered at the time of drilling (NGWE). 2. No ground water measured at the end of day (NGWM).

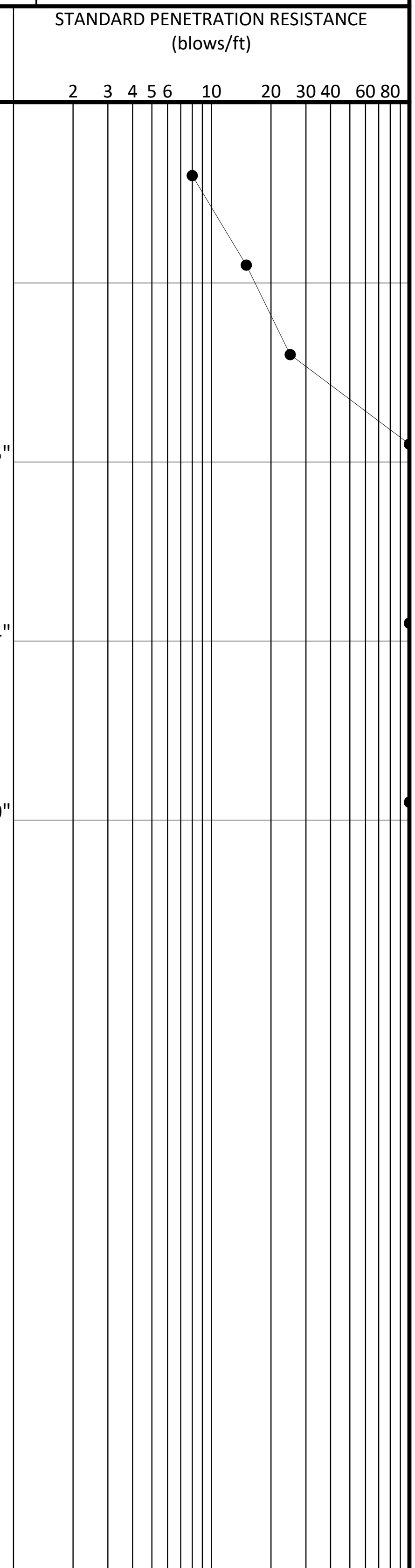
DEPTH (feet)	GRAPHIC LOG	GEOLOGIC DESCRIPTION	ELEV (feet)	N VALUE	STANDARD PENETRATION RESISTANCE (blows/ft) 2 3 4 5 6 10 20 30 40 60 80
0		PARTIALLY WEATHERED ROCK: Sampled as very dense tan brown silty fine to coarse SAND (SM), rock fragments	1390	6 - 50/3"	
		Very dense tan white fine to coarse SAND (SW), rock fragments		50/3"	
5			1385		
		Very dense tan brown fine to coarse SAND (SW), rock fragments		50/3"	
		Very dense tan white fine to coarse SAND (SW), rock fragments			
10			1380	50/4"	
		Boring terminated at 10 feet.			

CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
FORSYTH COUNTY, GEORGIA

LOG OF BORING B-4

GEOLOGIST: *NA*	ELEVATION (feet): *1388*	NOTES: 1. No groundwater encountered at the time of drilling (NGWE). 2. No ground water measured at the end of day (NGWM).
DATE DRILLED: *12/29/2022*	BORING DEPTH (feet): *20*	
DRILLER: *KILMAN BROS., INC.*	WATER LEVEL ▽ TOB (feet): *NGWE* ▼ 24HR (feet): *NGWM*	
DRILLING METHOD: *HOLLOW STEM AUGER WTIH AUTOMATIC HAMMER*		

DEPTH (feet)	GEOLOGIC DESCRIPTION	ELEV (feet)	N VALUE
0	RESIDUUM: Firm red brown sandy CLAY (CL)	1388	8
5	Medium dense slightly micaceous tan brown silty fine to medium SAND (SM)	1383	15
	Medium dense slightly micaceous tan white silty fine to medium SAND (SM)		25
10	PARTIALLY WEATHERED ROCK: Sampled as very dense tan white silty fine to coarse SAND (SM)	1378	50/5"
15	Very dense tan pinkish white fine to coarse SAND (SW), rock fragments	1373	50/4"
20		1368	50/0"
	Boring terminated at 20 feet.		



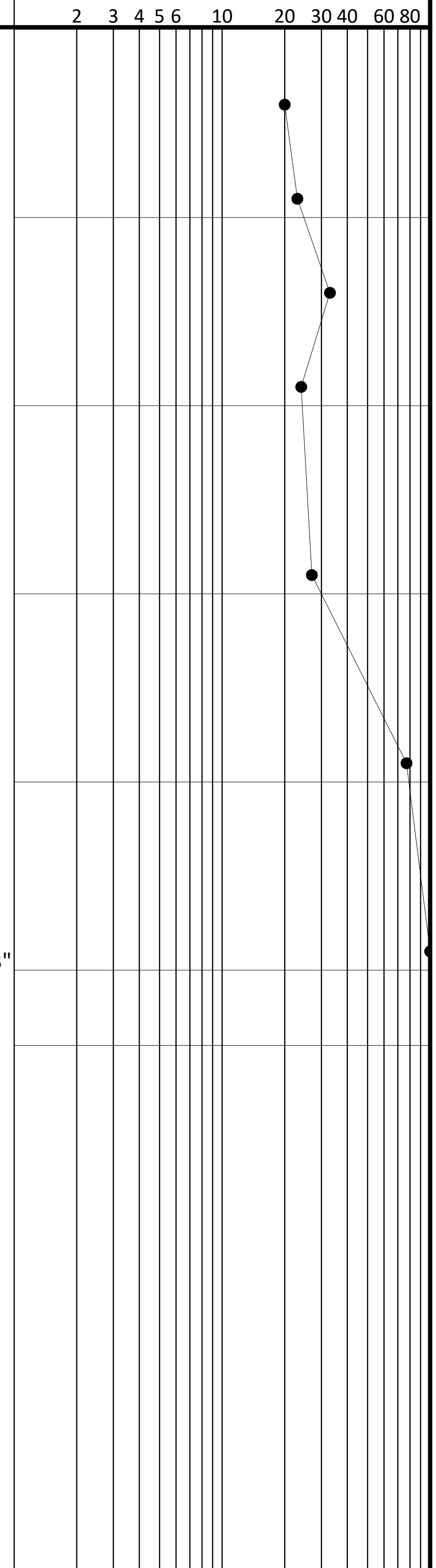
CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
FORSYTH COUNTY, GEORGIA

LOG OF BORING B-5

GEOLOGIST: *NA*	ELEVATION (feet): *1389*	NOTES: 1. No groundwater encountered at the time of drilling (NGWE). 2. No ground water measured at the end of day (NGWM).
DATE DRILLED: *12/28/2022*	BORING DEPTH (feet): *27*	
DRILLER: *KILMAN BROS., INC.*	WATER LEVEL ▽ TOB (feet): *NGWE* ▼ 24HR (feet): *NGWM*	
DRILLING METHOD: *HOLLOW STEM AUGER WTIH AUTOMATIC HAMMER*		

DEPTH (feet)	GEOLOGIC DESCRIPTION	ELEV (feet)	N VALUE
0	RESIDUUM: Medium dense orange pinkish tan silty fine to medium SAND (SM)	1389	20
	Medium dense reddish white silty fine to coarse SAND (SM)		23
5		1384	
	Hard slightly micaceous tan white sandy SILT (ML)		33
	Very stiff brown white fine to coarse sandy SILT (ML)		24
10		1379	
15		1374	27
	Very dense tan white fine to coarse SAND (SW), rock fragments		77
20	PARTIALLY WEATHERED ROCK: Sampled as Very dense pinkish white fine to coarse SAND (SW)	1369	
25		1364	50/3"
	Auger refusal at 27 feet.		

STANDARD PENETRATION RESISTANCE (blows/ft)



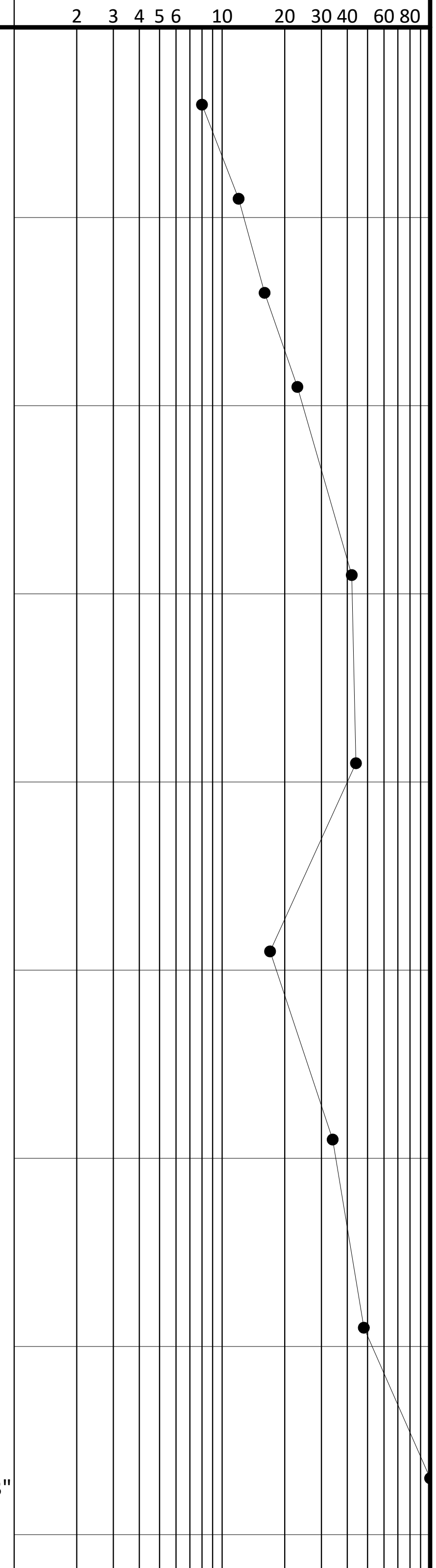
CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
FORSYTH COUNTY, GEORGIA

LOG OF BORING B-6

GEOLOGIST: *NA*	ELEVATION (feet): *1389*	NOTES: 1. No groundwater encountered at the time of drilling (NGWE). 2. No ground water measured at the end of day (NGWM). 3. Undisturbed sample collected from offset auger boring 3 feet north of B-6.
DATE DRILLED: *12/28/2022*	BORING DEPTH (feet): *48*	
DRILLER: *KILMAN BROS., INC.*	WATER LEVEL ▽ TOB (feet): *NGWE* ▼ 24HR (feet): *NGWM*	
DRILLING METHOD: *HOLLOW STEM AUGER WTIH AUTOMATIC HAMMER*		

DEPTH (feet)	GEOLOGIC DESCRIPTION	ELEV (feet)	N VALUE
0	POSSIBLE FILL: Loose red brown silty fine to coarse SAND (SM), rock fragments, moist	1389	8
	RESIDUUM: Stiff tan pinkish brown sandy SILT (ML), moist		
5	Medium dense silty fine to coarse SAND (SM) Undisturbed sample (Shelby Tube) 5' to 7'	1384	12
			16
	Medium dense tan white slightly micaceous silty fine to medium SAND (SM)		
10		1379	23
	Dense white tan fine to coarse SAND (SW)		
15		1374	42
	Dense pinkish white slightly silty fine to coarse SAND (SW), rock fragments		
20		1369	44
	Medium dense white pinkish tan silty fine to coarse SAND (SM)		
25		1364	17
	Dense tan brown slightly micaceous silty fine to coarse SAND (SM), rock fragments		
30		1359	34
35		1354	48
	PARTIALLY WEATHERED ROCK: Sampled as very dense tan white silty fine to coarse SAND (SM), rock fragments		50/3"
40		1349	

STANDARD PENETRATION RESISTANCE (blows/ft)



CITY OF CUMMING, GEORGIA
HIGHWAY 20 SAWNEE TANK SITE SLOPE FAILURE
FORSYTH COUNTY, GEORGIA

LOG OF BORING B-6

GEOLOGIST: *NA*	ELEVATION (feet): *1389*	NOTES: 1. No groundwater encountered at the time of drilling (NGWE). 2. No ground water measured at the end of day (NGWM). 3. Undisturbed sample collected from offset auger boring 3 feet north of B-6.
DATE DRILLED: *12/28/2022*	BORING DEPTH (feet): *48*	
DRILLER: *KILMAN BROS., INC.*	WATER LEVEL ▽ TOB (feet): *NGWE* ▼ 24HR (feet): *NGWM*	
DRILLING METHOD: *HOLLOW STEM AUGER WTIH AUTOMATIC HAMMER*		

DEPTH (feet)	GRAPHIC LOG	GEOLOGIC DESCRIPTION	ELEV (feet)	N VALUE	STANDARD PENETRATION RESISTANCE (blows/ft) 2 3 4 5 6 10 20 30 40 60 80
		PARTIALLY WEATHERED ROCK: Sampled as very dense tan white silty fine to coarse SAND (SM), rock fragments			
45			1344	50/5"	
		Auger refusal at 48 feet.			

HAND AUGER BORING DATA SUMMARY
City of Cumming – Highway 20 Sawnee Tank Site
Slope Failure Project
Cumming, Forsyth County, Georgia
GeoSystems Project No. 22-2875

BORING NUMBER	DEPTH From - To (feet)	SOIL DESCRIPTION
HAB-1	0-3.5	Fill – Dark gray to black slightly silty fine to coarse SAND and Gravel (SM/GM) (apparent loose asphalt waste)
	3.5-4.0	Yellow and orange clayey to silty fine to coarse SAND (SC/SM) with rock fragments
	4.0	Boring terminated (difficult drilling)
HAB-2	0-3.8	Fill – Dark gray to black slightly silty fine to coarse SAND and Gravel (SM/GM) (apparent loose asphalt waste)
	3.8-4.8	Yellow and orange clayey to silty fine to coarse SAND (SC/SM) with rock fragments
	4.8	Boring terminated (difficult drilling)
HAB-3	0-1.6	Fill – Dark gray to black slightly silty fine to coarse SAND and Gravel (SM/GM) (apparent loose asphalt waste)
	1.6	Auger refusal (refusal at depths of 0 to 1.6 feet at six locations)
HAB-4	0-0.6	Fill – Dark gray to black slightly silty fine to coarse SAND and Gravel (SM/GM) (apparent loose asphalt waste)
	0.6-3.0	Pink tan silty fine to medium SAND (SM) to fine sandy SILT (ML) with roots, wood fragments, unidentified organic matter and asphalt fragments
	3.0-3.4	Orange brown silty fine to coarse SAND (SM) with rock fragments
	3.4	Boring terminated (difficult drilling)
HAB-5	0-0.6	Fill – Gray brown silty fine to medium SAND (SM) with asphalt fragments
	0.6-8.4	Orange to pink brown silty fine to coarse SAND (SM) with roots, rock fragments, very moist
	8.4	Boring terminated (difficult drilling)

Notes:

1. Hand auger borings were drilled on 02/03/2023 by Larry Mullins and Andy Christian.
2. Groundwater was not encountered in the borings at the time drilled.
3. Observed nine, approximate 7-inch diameter cast iron pipes installed vertically into the ground along a line beginning 21 feet southwest of HAB-5. A steel beam was also observed installed vertically in the same area on the next bench up the slope.

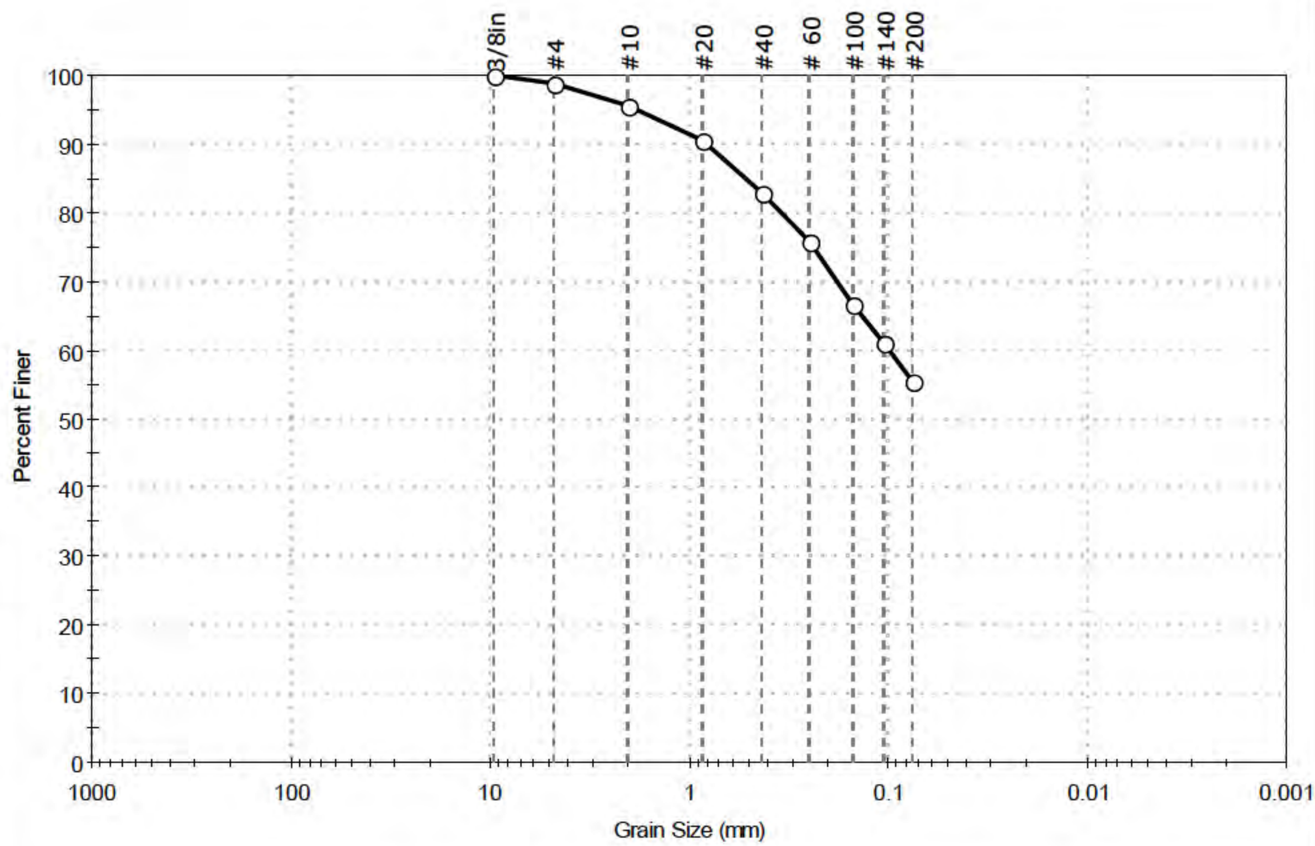
APPENDIX E

LABORATORY TEST REPORTS

GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-4	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-1	Test Date:	01/05/23	Checked By:	MCM
Depth :	1-2.5 ft	Test Id:	341685		
Test Comment:	---				
Visual Description:	Moist, reddish brown sandy clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.1	43.5	55.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	99		
#10	2.00	95		
#20	0.85	91		
#40	0.42	83		
# 60	0.25	76		
#100	0.15	67		
#140	0.11	61		
#200	0.075	55		

Coefficients

D_{85} =0.5092 mm	D_{30} =N/A
D_{60} =0.0997 mm	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Sandy Lean CLAY (CL)

AASHTO Clayey Soils (A-7-6 (8))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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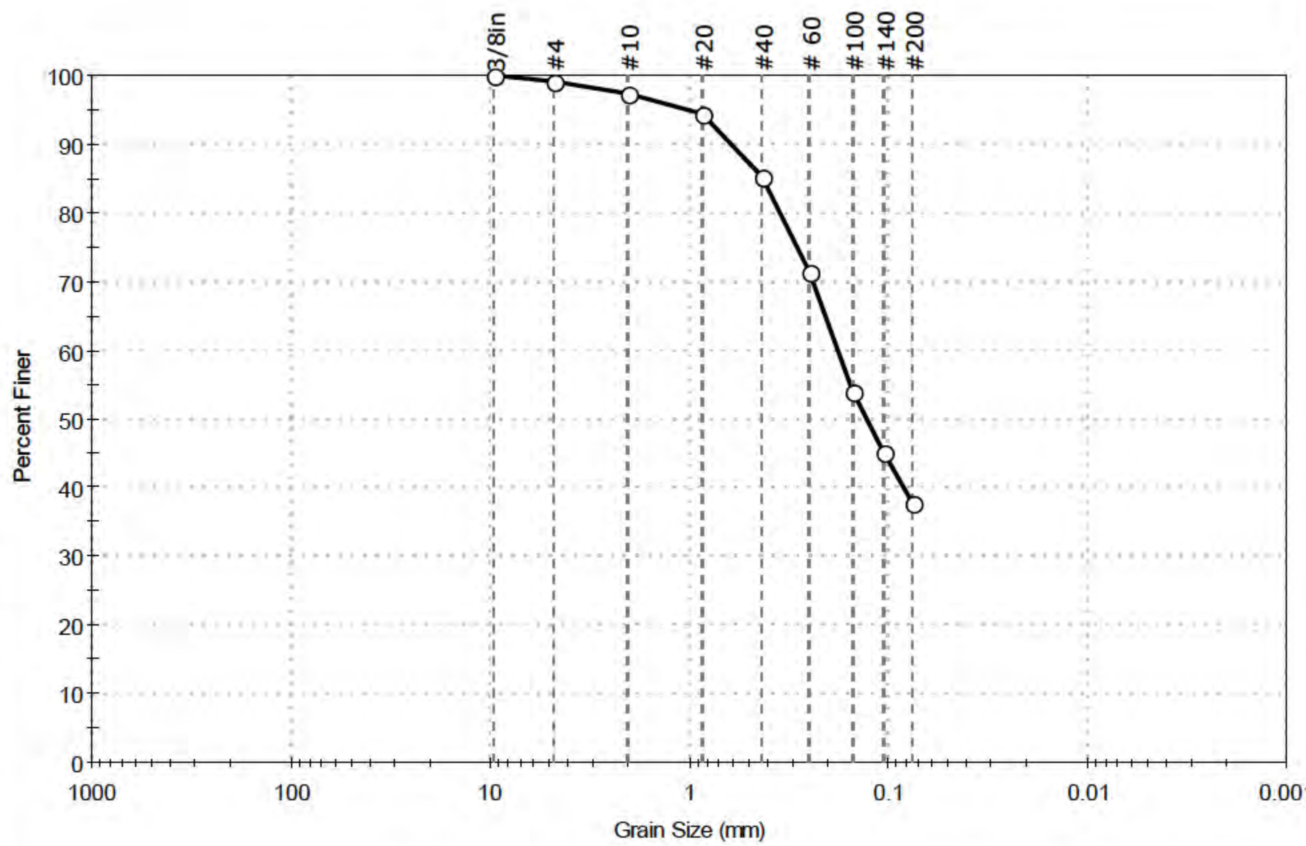
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-5	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-1	Test Date:	01/05/23	Checked By:	MCM
Depth :	1-2.5 ft	Test Id:	341686		

Test Comment: ---
Visual Description: Moist, yellowish red silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.9	61.3	37.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	99		
#10	2.00	97		
#20	0.85	94		
#40	0.42	85		
# 60	0.25	71		
#100	0.15	54		
#140	0.11	45		
#200	0.075	38		

Coefficients

D_{85} =0.4217 mm　D_{30} =N/A
D_{60} =0.1795 mm　D_{15} =N/A
D_{50} =0.1286 mm　D_{10} =N/A
C_u =N/A　C_c =N/A

Classification

ASTM　N/A

AASHTO　Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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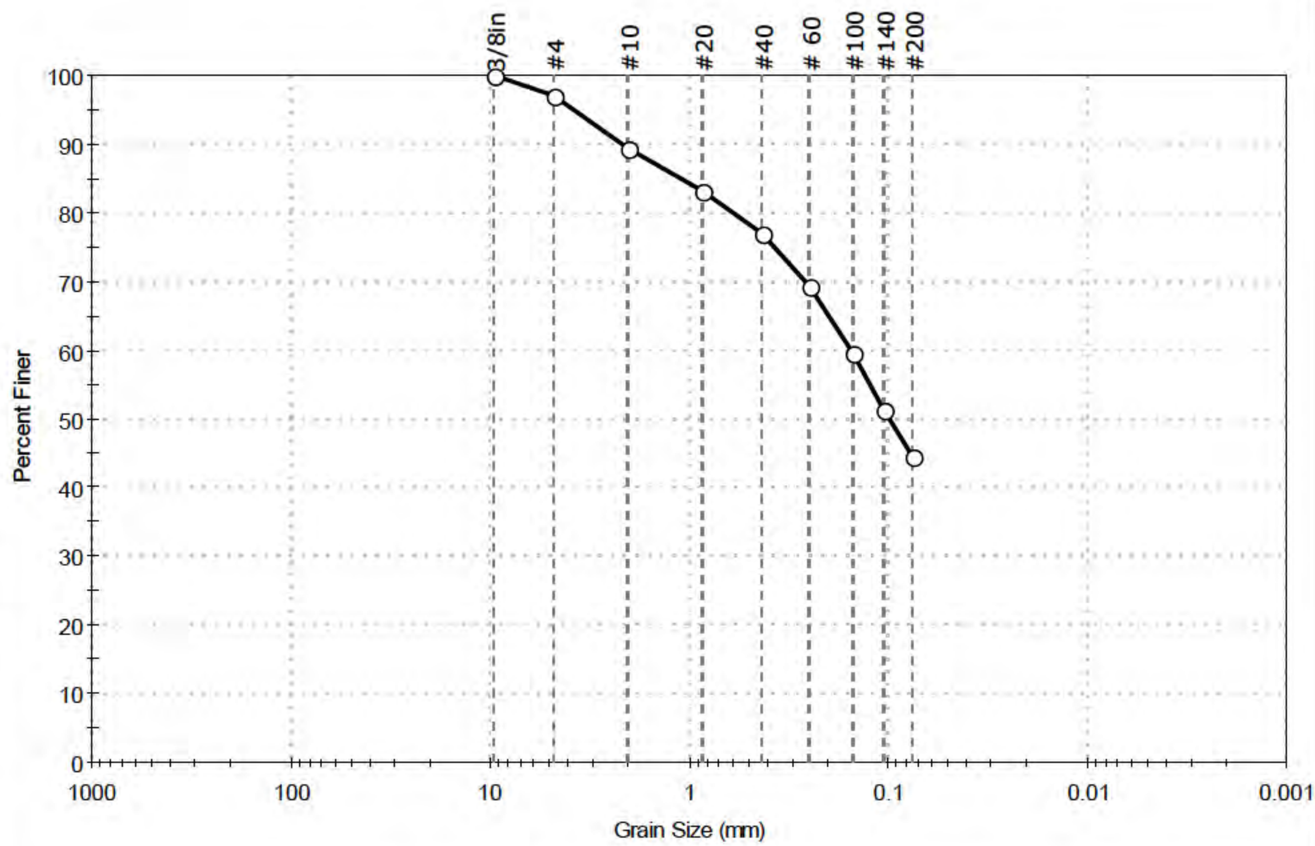
GeoTesting EXPRESS

Client:	GeoSystems Engineering Inc		
Project:	Cumming - Highway 20 Tank Site Slope Failure		
Location:	Cumming, Forsyth County, Georgia	Project No:	GTX-316581

Boring ID:	B-5	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-2	Test Date:	01/05/23	Checked By:	MCM
Depth :	3.5-5 ft	Test Id:	341687		

Test Comment:	---
Visual Description:	Moist, reddish brown silty sand
Sample Comment:	---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.0	52.4	44.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	97		
#10	2.00	90		
#20	0.85	83		
#40	0.42	77		
# 60	0.25	69		
#100	0.15	60		
#140	0.11	51		
#200	0.075	45		

Coefficients

D_{85} = 1.0965 mm	D_{30} = N/A
D_{60} = 0.1523 mm	D_{15} = N/A
D_{50} = 0.0988 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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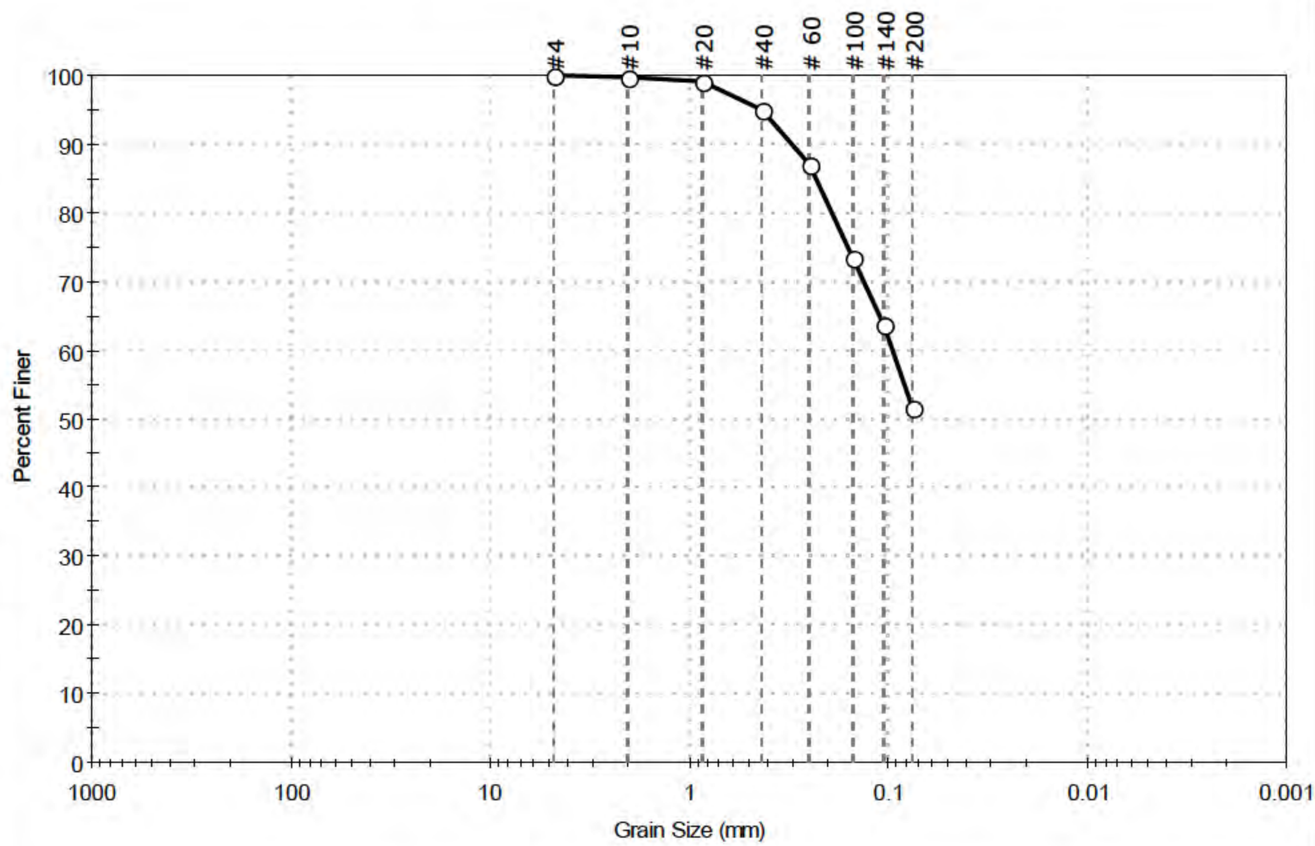
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.		
Project:	Cumming - Highway 20 Tank Site Slope Failure		
Location:	Cumming, Forsyth County, Georgia	Project No:	GTX-316581

Boring ID:	B-5	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-3	Test Date:	01/05/23	Checked By:	MCM
Depth :	6-7.5 ft	Test Id:	341688		

Test Comment: ---
Visual Description: Moist, reddish brown sandy silt
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	48.3	51.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	95		
# 60	0.25	87		
#100	0.15	74		
#140	0.11	64		
#200	0.075	52		

Coefficients

D_{85} =0.2323 mm
D_{30} =N/A
D_{60} =0.0954 mm
D_{15} =N/A
D_{50} =N/A
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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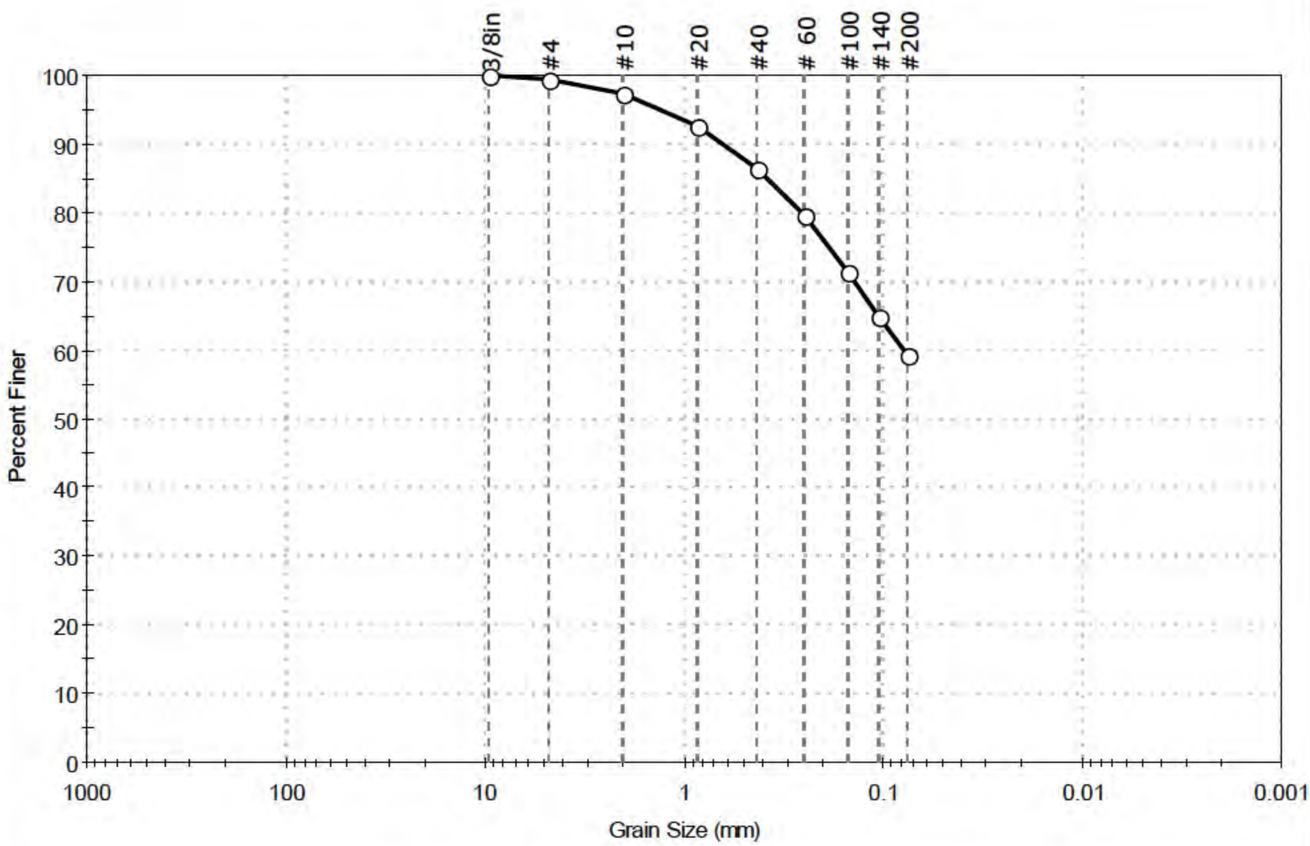
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.		
Project:	Cumming - Highway 20 Tank Site Slope Failure		
Location:	Cumming, Forsyth County, Georgia	Project No:	GTX-316581

Boring ID:	B-5	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-4	Test Date:	01/05/23	Checked By:	MCM
Depth :	8.5-10 ft	Test Id:	341689		

Test Comment:	---
Visual Description:	Moist, reddish brown sandy silt
Sample Comment:	---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	40.1	59.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	99		
#10	2.00	97		
#20	0.85	93		
#40	0.42	86		
# 60	0.25	80		
#100	0.15	71		
#140	0.11	65		
#200	0.075	59		

Coefficients

D_{85} =0.3806 mm D_{30} =N/A
D_{60} =0.0785 mm D_{15} =N/A
D_{50} =N/A D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM Sandy SILT (ML)

AASHTO Clayey Soils (A-7-5 (7))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting EXPRESS

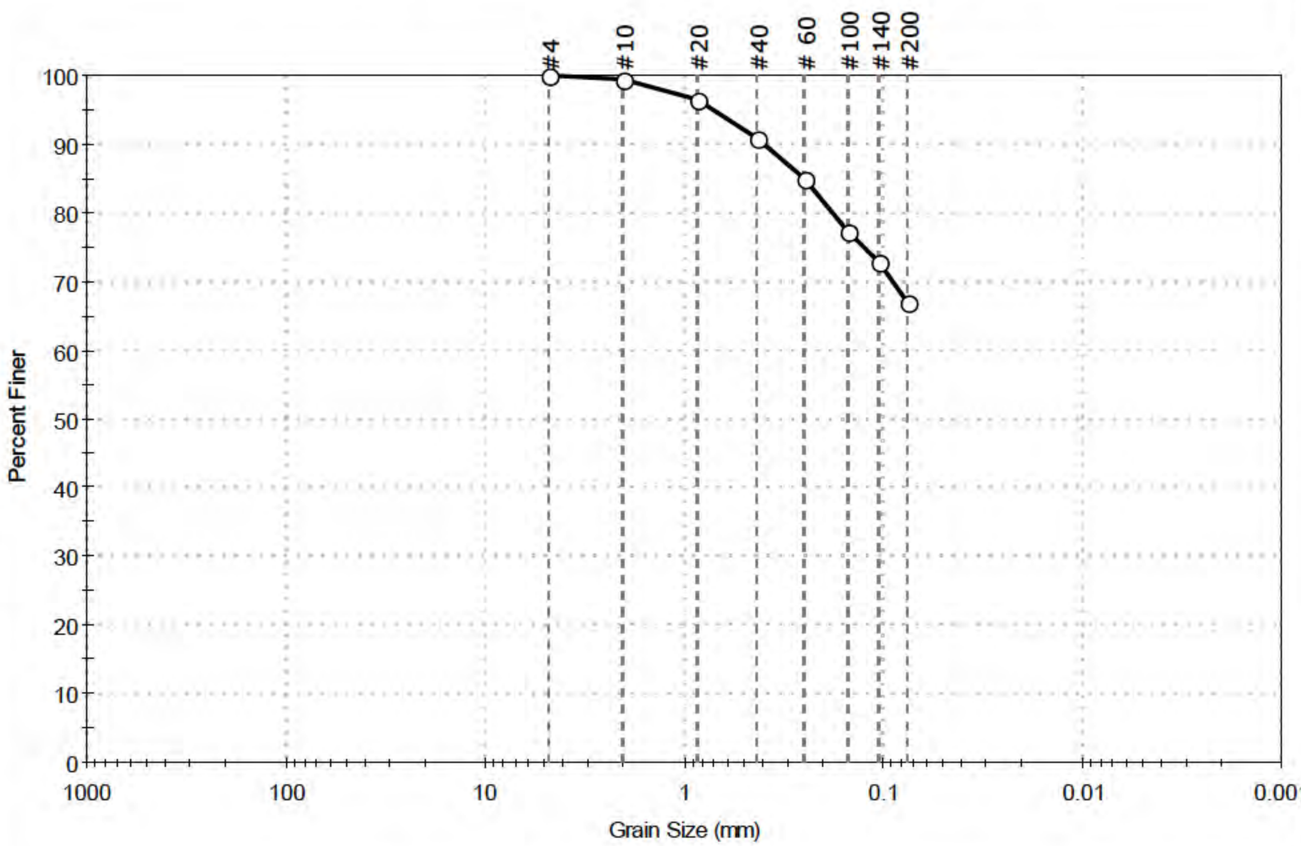
Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-6	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-2	Test Date:	01/05/23	Checked By:	MCM
Depth :	3.5-5 ft	Test Id:	341690		

Test Comment: ---

Visual Description: Moist, yellowish red sandy silt

Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	33.1	66.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	96		
#40	0.42	91		
# 60	0.25	85		
#100	0.15	77		
#140	0.11	73		
#200	0.075	67		

Coefficients

D_{85} =0.2538 mm — D_{30} =N/A

D_{60} =N/A — D_{15} =N/A

D_{50} =N/A — D_{10} =N/A

C_u =N/A — C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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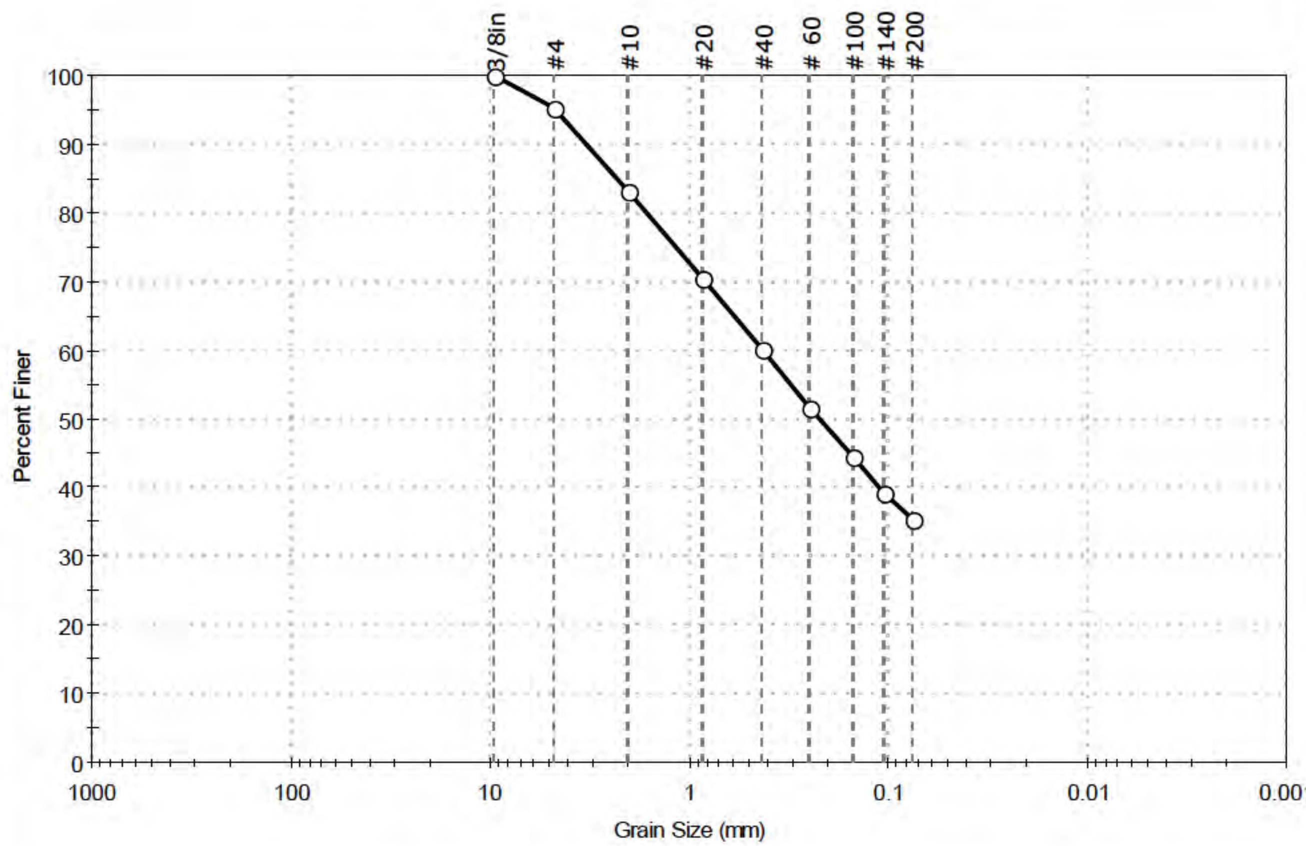
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-6	Sample Type:	tube	Tested By:	mgh
Sample ID:	UDS	Test Date:	01/09/23	Checked By:	MCM
Depth :	5-7 ft	Test Id:	341695		
Test Comment:	---				
Visual Description:	Moist, light brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	4.7	59.9	35.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	95		
#10	2.00	83		
#20	0.85	70		
#40	0.42	60		
# 60	0.25	52		
#100	0.15	45		
#140	0.11	39		
#200	0.075	35		

Coefficients

D_{85} =2.2616 mm D_{30} =N/A
D_{60} =0.4232 mm D_{15} =N/A
D_{50} =0.2228 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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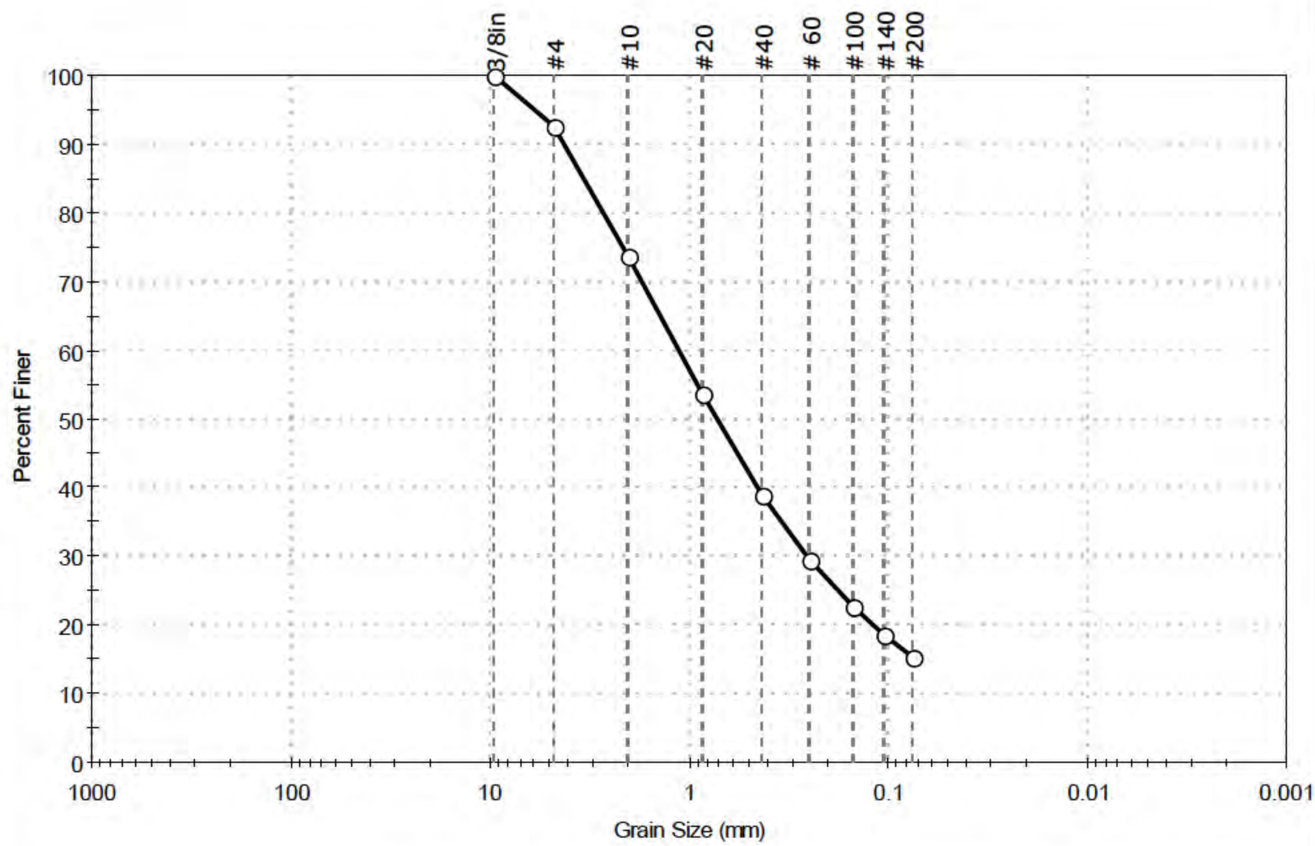
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-6	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-6	Test Date:	01/05/23	Checked By:	MCM
Depth :	18.5-20 ft	Test Id:	341691		
Test Comment:	---				
Visual Description:	Moist, pink silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	7.3	77.2	15.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	93		
#10	2.00	74		
#20	0.85	54		
#40	0.42	39		
# 60	0.25	30		
#100	0.15	23		
#140	0.11	19		
#200	0.075	15		

Coefficients

D_{85} =3.3360 mm　　D_{30} =0.2564 mm

D_{60} =1.1069 mm　　D_{15} =N/A

D_{50} =0.7113 mm　　D_{10} =N/A

C_u =N/A　　C_c =N/A

Classification

ASTM　N/A

AASHTO　Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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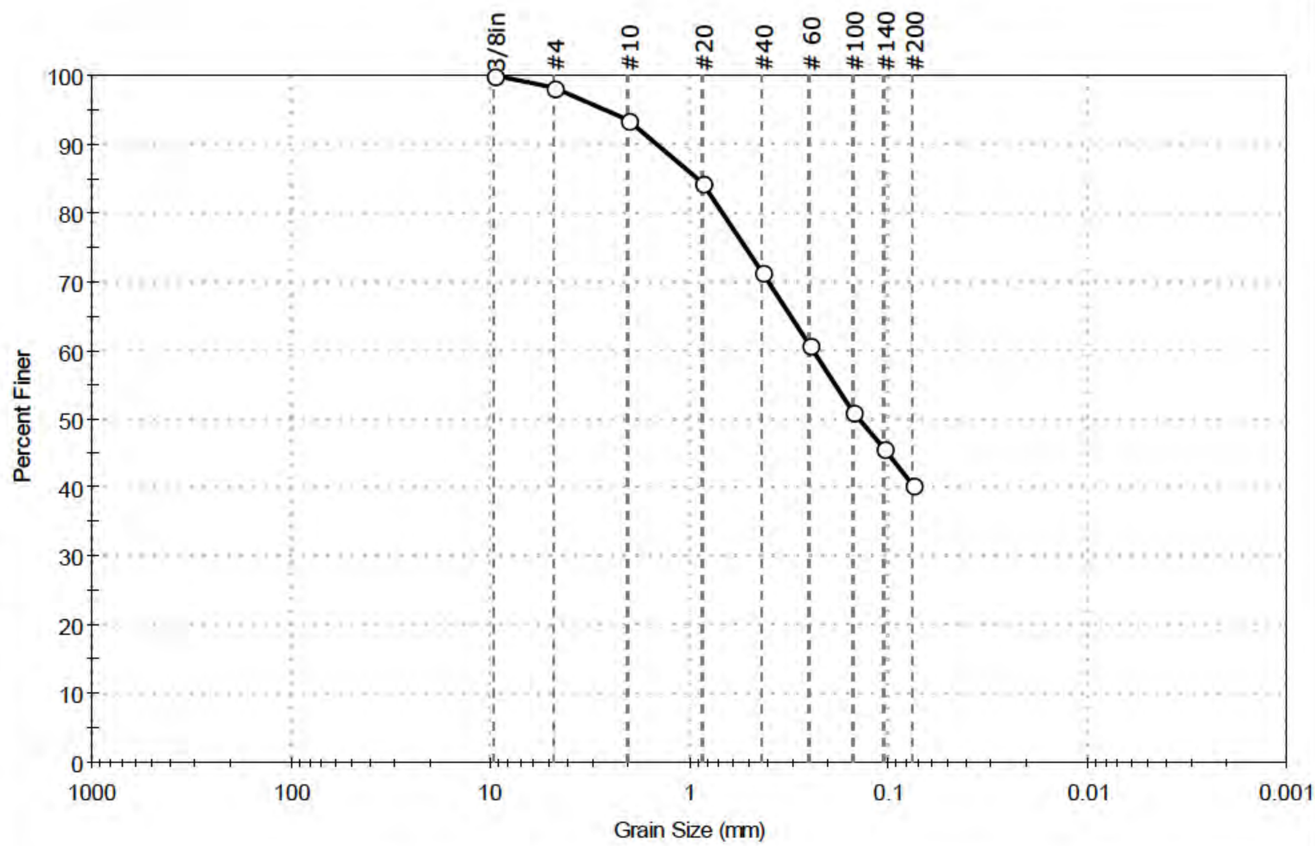
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-6	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-7	Test Date:	01/05/23	Checked By:	MCM
Depth :	23.5-25 ft	Test Id:	341692		
Test Comment:	---				
Visual Description:	Moist, light reddish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.9	57.8	40.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	98		
#10	2.00	94		
#20	0.85	85		
#40	0.42	71		
# 60	0.25	61		
#100	0.15	51		
#140	0.11	46		
#200	0.075	40		

Coefficients

D_{85} =0.8908 mm	D_{30} =N/A
D_{60} =0.2394 mm	D_{15} =N/A
D_{50} =0.1401 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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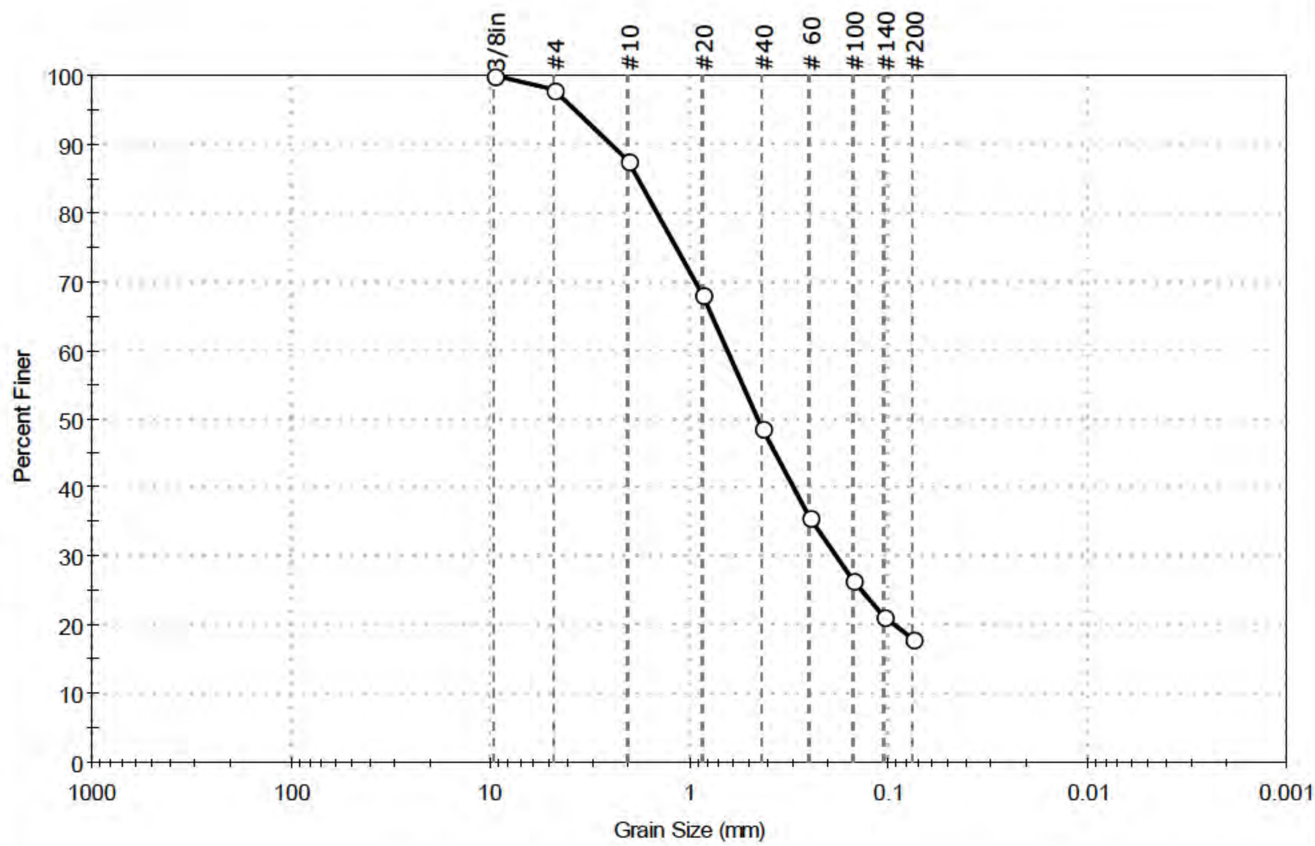
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-6	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-9	Test Date:	01/05/23	Checked By:	MCM
Depth :	33.5-35 ft	Test Id:	341693		
Test Comment:	---				
Visual Description:	Moist, light reddish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.2	79.9	17.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	98		
#10	2.00	88		
#20	0.85	68		
#40	0.42	49		
# 60	0.25	36		
#100	0.15	27		
#140	0.11	21		
#200	0.075	18		

Coefficients

D_{85} =1.7913 mm

D_{30} =0.1815 mm

D_{60} =0.6374 mm

D_{15} =N/A

D_{50} =0.4460 mm

D_{10} =N/A

C_u =N/A

C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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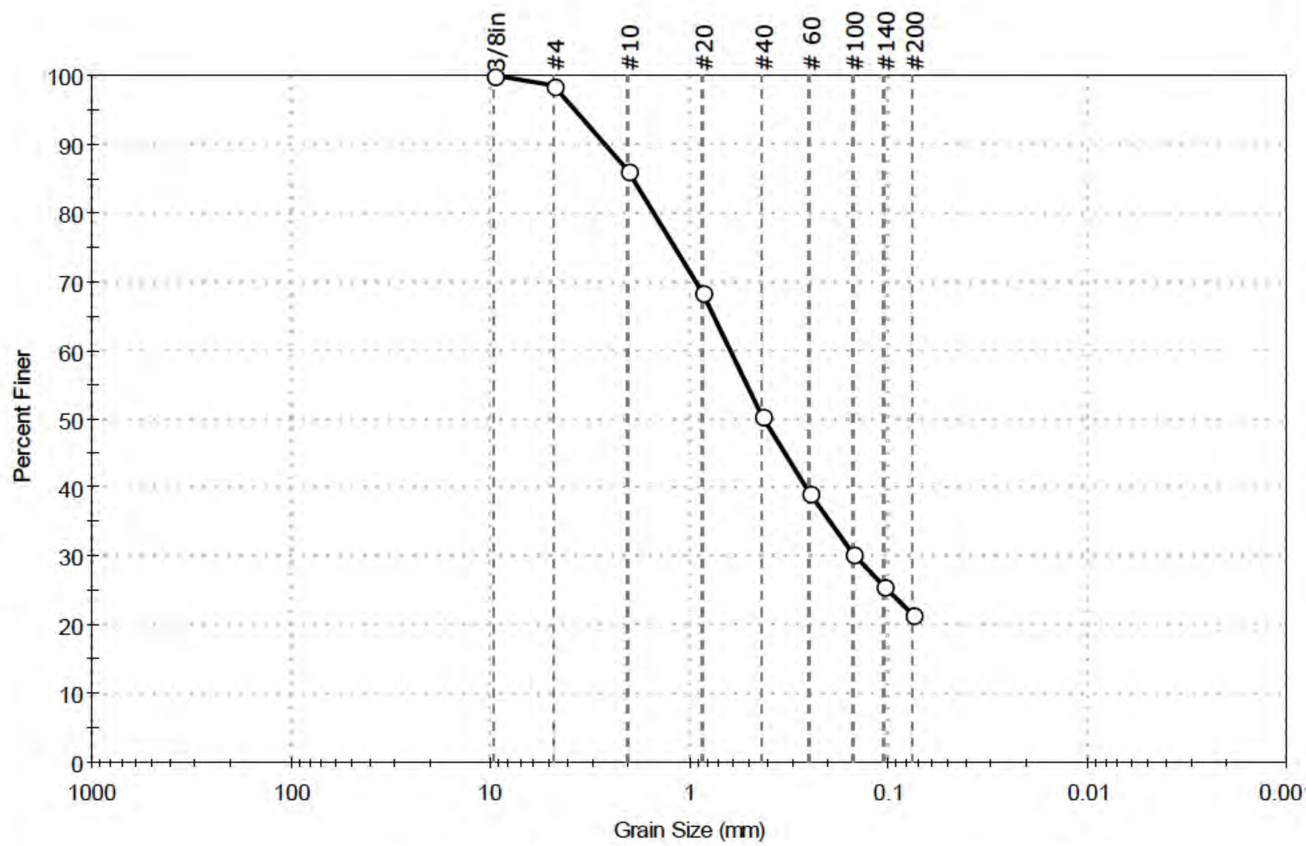
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.		
Project:	Cumming - Highway 20 Tank Site Slope Failure		
Location:	Cumming, Forsyth County, Georgia	Project No:	GTX-316581

Boring ID:	B-6	Sample Type:	jar	Tested By:	mgh
Sample ID:	SS-10	Test Date:	01/05/23	Checked By:	MCM
Depth :	38.5-40 ft	Test Id:	341694		

Test Comment: ---
Visual Description: Moist, pink silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.6	77.0	21.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8in	9.50	100		
#4	4.75	98		
#10	2.00	86		
#20	0.85	69		
#40	0.42	50		
# 60	0.25	39		
#100	0.15	30		
#140	0.11	26		
#200	0.075	21		

Coefficients

D_{85} =1.8846 mm | D_{30} =0.1471 mm
D_{60} =0.6142 mm | D_{15} =N/A
D_{50} =0.4184 mm | D_{10} =N/A
C_u =N/A | C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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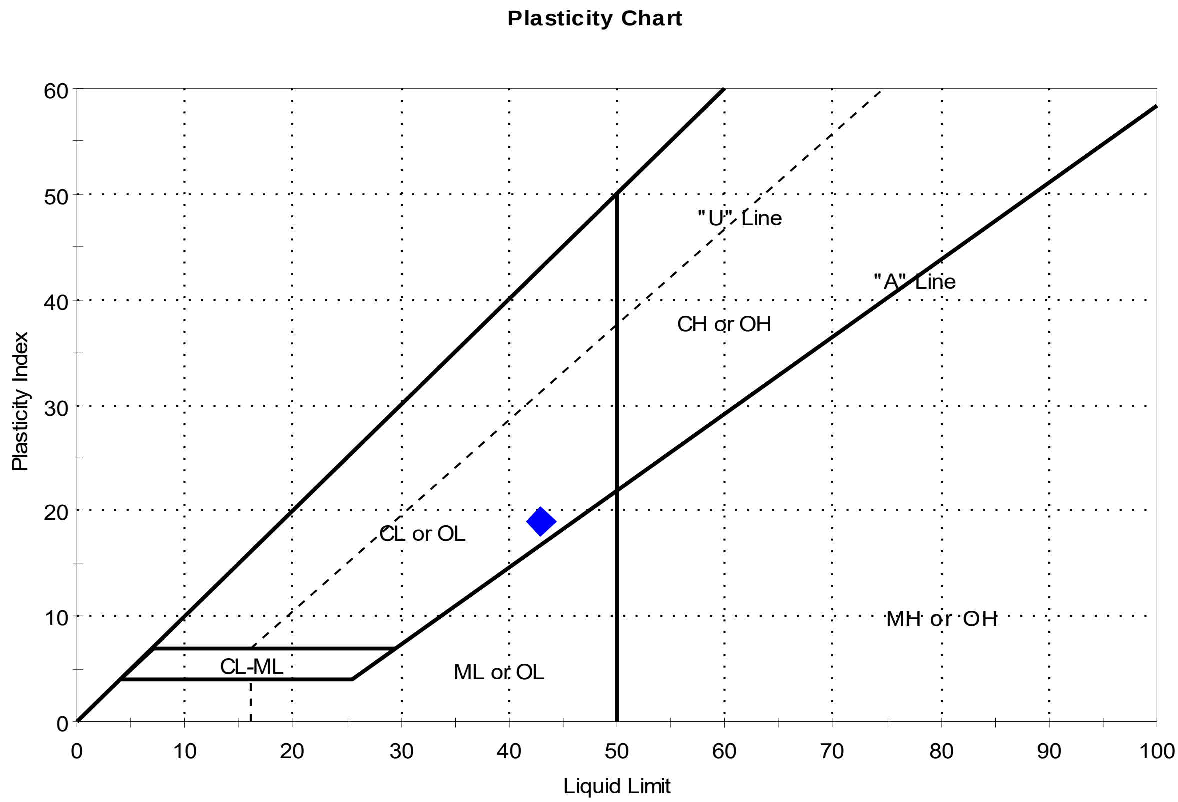
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.		
Project:	Cumming - Highway 20 Tank Site Slope Failure		
Location:	Cumming, Forsyth County, Georgia	Project No:	GTX-316581
Boring ID: B-4	Sample Type: jar	Tested By:	jbh
Sample ID: SS-1	Test Date: 01/04/23	Checked By:	MCM
Depth : 1-2.5 ft	Test Id: 341697		
Test Comment:	---		
Visual Description:	Moist, reddish brown sandy clay		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	SS-1	B-4	1-2.5 ft	22	43	24	19	-0.1	Sandy Lean CLAY (CL)

Sample Prepared using the WET method

17% Retained on #40 Sieve

Dry Strength: HIGH

Dilatancy: SLOW

Toughness: MEDIUM

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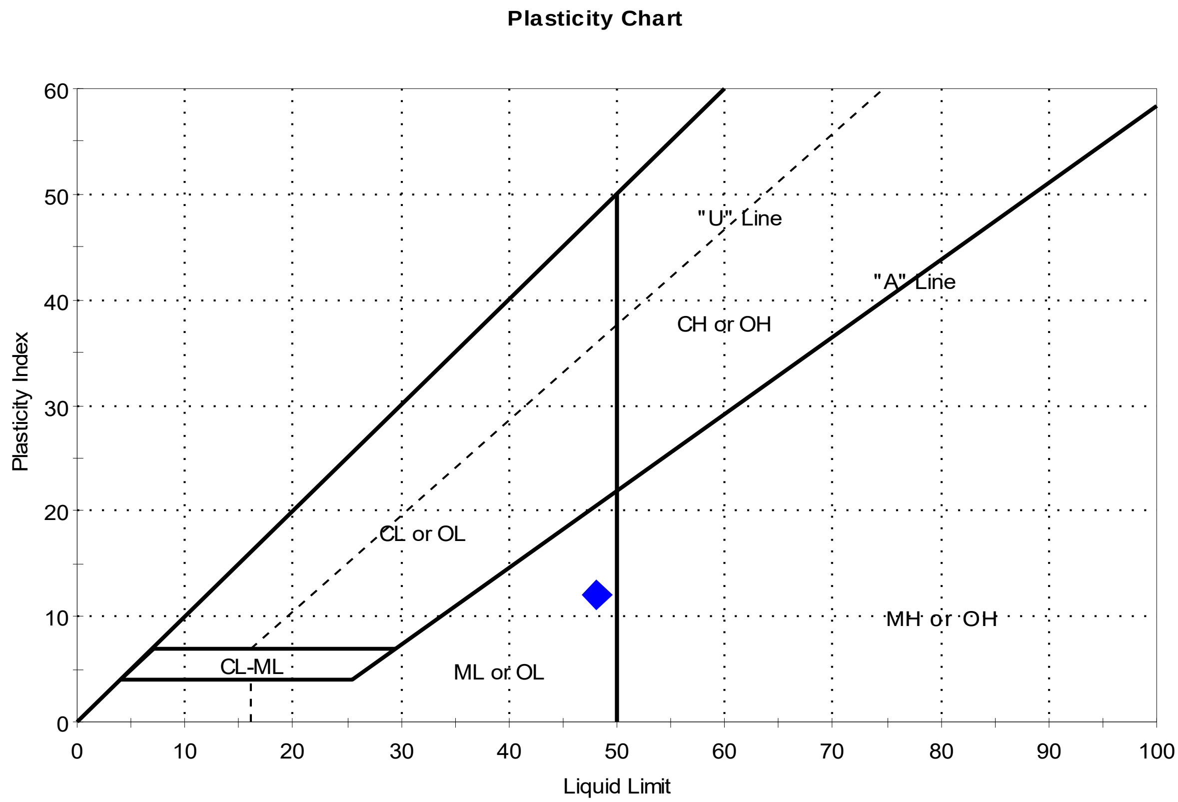
GeoTesting EXPRESS

Client:	GeoSystems Engineering, Inc.				
Project:	Cumming - Highway 20 Tank Site Slope Failure				
Location:	Cumming, Forsyth County, Georgia			Project No:	GTX-316581
Boring ID:	B-5	Sample Type:	jar	Tested By:	jbh
Sample ID:	SS-4	Test Date:	01/04/23	Checked By:	MCM
Depth :	8.5-10 ft	Test Id:	341698		
Test Comment:	---				
Visual Description:	Moist, reddish brown sandy silt				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	SS-4	B-5	8.5-10 ft	23	48	36	12	-1.1	Sandy SILT (ML)

Sample Prepared using the WET method

14% Retained on #40 Sieve

Dry Strength: MEDIUM

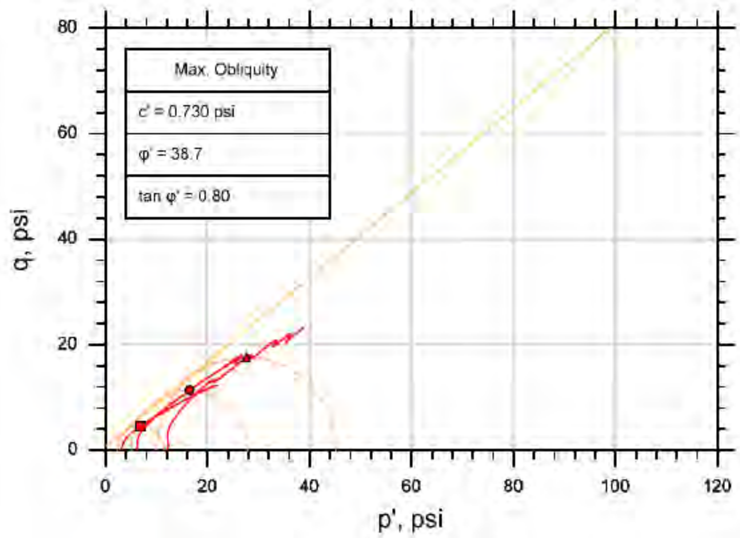
Dilatancy: SLOW

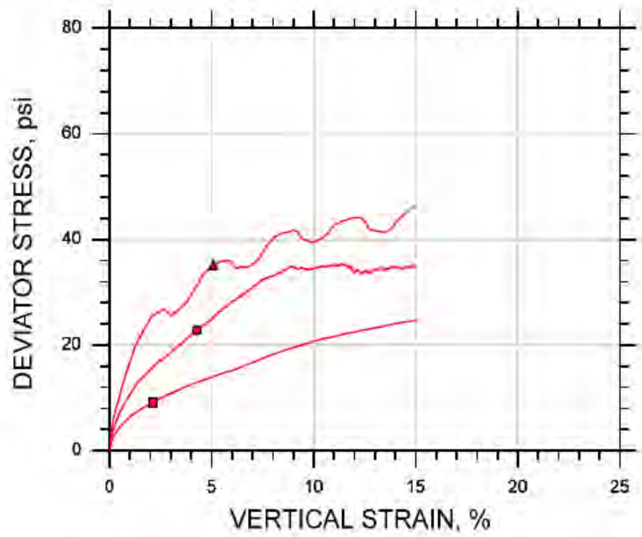
Toughness: MEDIUM

GeoTesting EXPRESS

Client: GeoSystems Engineering, Inc.	
Project Name: Cumming Hwy 20 Tank Site Slope	
Project Location: Cumming, Forsyth Co, Georgia	
Project Number: GTX-316581	
Tested By: cag	Checked By: mcm
Boring ID: B-6	
Preparation: intact	
Description: Moist, light brown silty sand	
Classification: ---	
Group Symbol: ---	
Liquid Limit: ---	Plastic Limit: ---
Plasticity Index: ---	Estimated Specific Gravity: 2.65

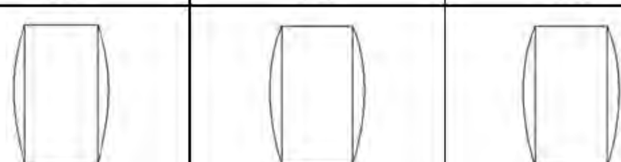
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●	▲	
Sample ID		UDS	UDS	UDS	
Depth, ft		5-7 ft	5-7 ft	5-7 ft	
Test Number		CU-1-1	CU-1-2	CU-1-3	
Initial	Height, in	5.990	5.900	6.240	
	Diameter, in	2.810	2.870	2.850	
	Moisture Content (from Cuttings), %	9.6	13.5	13.6	
	Dry Density, pcf	113.	108.	106.	
	Saturation (Wet Method), %	54.7	65.2	61.8	
	Void Ratio	0.467	0.561	0.593	
Before Shear	Moisture Content, %	17.3	20.3	20.2	
	Dry Density, pcf	113.	109.	109.	
	Cross-sectional Area (Method A), in²	6.177	6.432	6.245	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	0.458	0.548	0.546	
	Back Pressure, psi	83.00	121.0	123.0	
Vertical Effective Consolidation Stress, psi		2.974	5.995	11.97	
Horizontal Effective Consolidation Stress, psi		2.970	6.006	12.00	
Vertical Strain after Consolidation, %		0.04166	0.1919	0.6403	
Volumetric Strain after Consolidation, %		0.1404	0.6229	2.430	
Time to 50% Consolidation, min		---	---	0.6400	
Shear Strength, psi		4.565	11.39	17.57	
Strain at Failure, %		2.10	4.28	5.08	
Strain Rate, %/min		0.06000	0.06000	0.06000	
Deviator Stress at Failure, psi		9.131	22.79	35.15	
Effective Minor Principal Stress at Failure, psi		2.281	5.079	10.02	
Effective Major Principal Stress at Failure, psi		11.41	27.87	45.17	
B-Value		0.95	0.96	0.95	

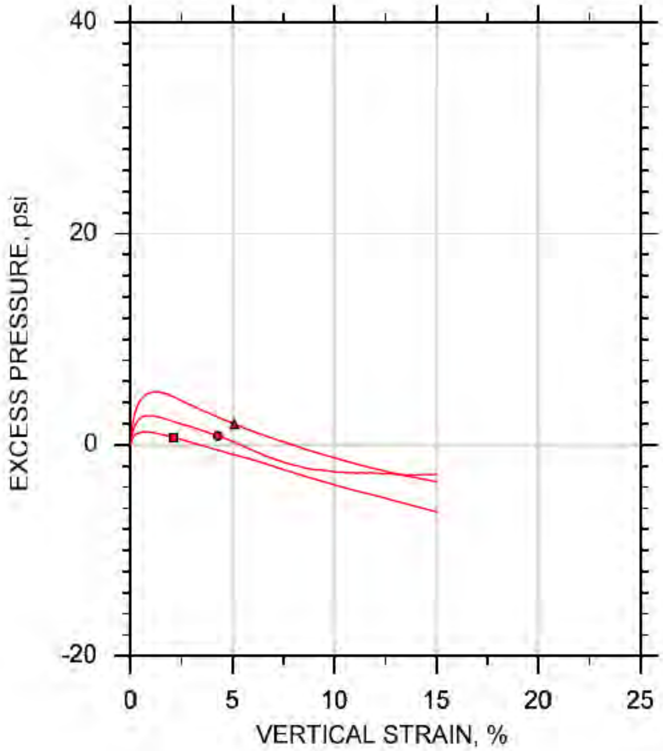
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

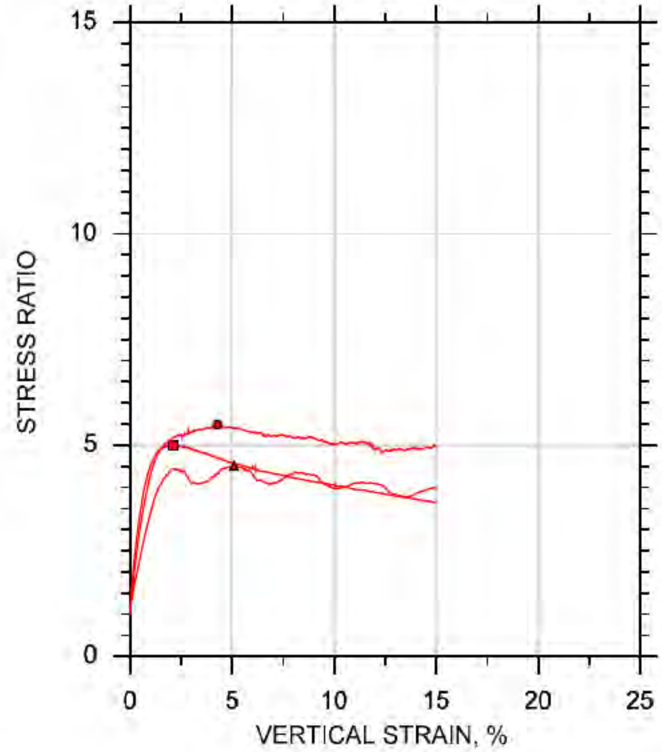


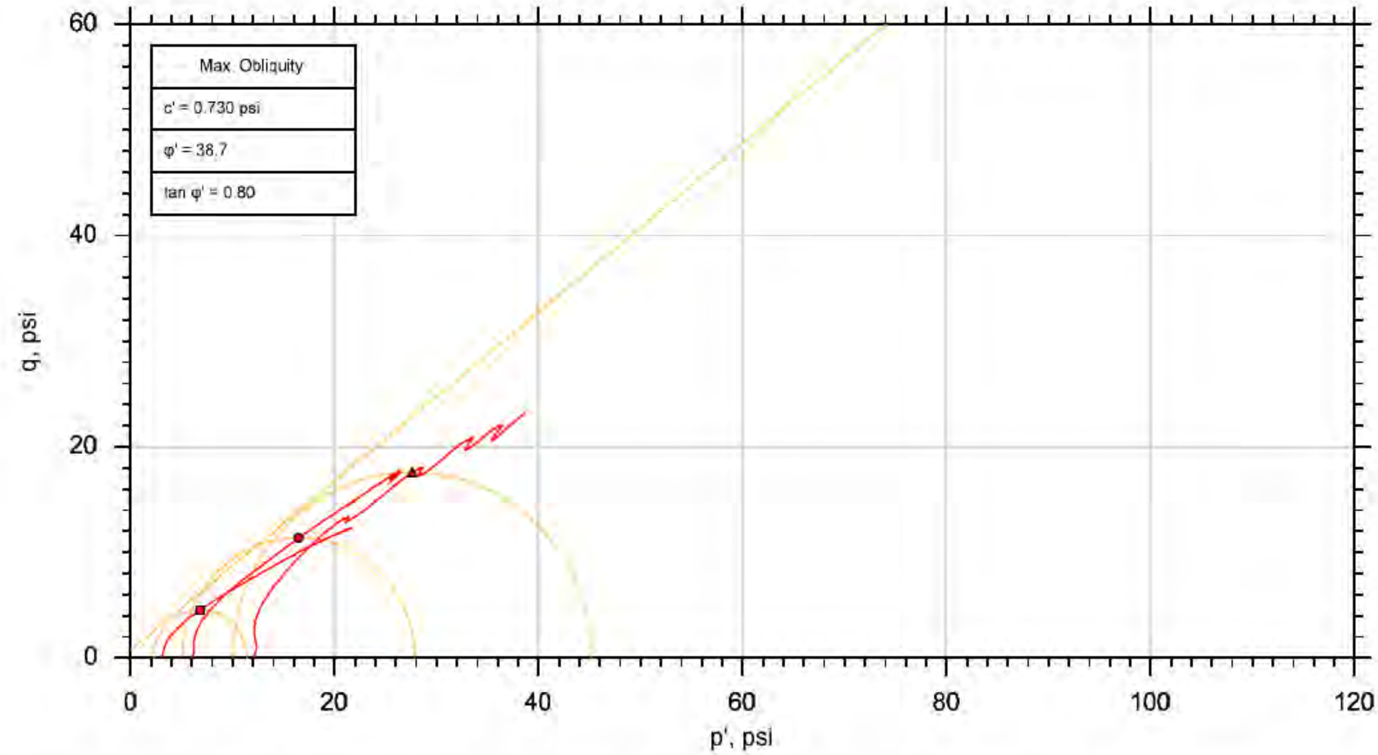
Remarks:

System D

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	UDS	CU-1-1	5-7 ft	cag	1/4/23	mcm	1/10/23	316581-CU-1-1m.dat
●	UDS	CU-1-2	5-7 ft	cag	1/4/23	mcm	1/10/23	316581-CU-1-2m.dat
▲	UDS	CU-1-3	5-7 ft	cag	1/4/23	mcm	1/10/23	316581-CU-1-3m.dat

GeoTesting EXPRESS

Project: Cumming Hwy 20 Tank Site Slope	Location: Cumming, Forsyth Co, Georgia	Project No.: GTX-316581
Boring No.: B-6	Sample Type: intact	
Description: Moist, light brown silty sand		
Remarks: System D		

APPENDIX F

COLLIER GEOPHYSICS
GEOPHYSICAL LETTER REPORT

COLLIER GEOPHYSICS
Surface • Marine • Borehole

March 17, 2023

Larry D. Mullins, P.E.

Geosystems Engineering, Inc.
11285 Elkins Road, Suite F2
Roswell, Georgia 30076
(678)-722-0340

Email: ldm@geo-sys.com

RE: Geophysical Letter Report | Project # 230087
Sawnee Water Tank Site Geophysical Investigation
Cumming, Georgia

Collier Geophysics, LLC (Collier) conducted a geophysical investigation on behalf of Geosystems Engineering, Inc. (Client) at the Sawnee Water Tank Site located in Cumming, Georgia (**Figures 1 and A-1**). The objectives of the investigation were to characterize the subsurface in terms of P-wave velocity (Vp) and shear-wave velocity (Vs) along a slope adjacent to a recently failed slope at the site. Geosystems Engineering aims to use these geophysical results to evaluate potential future issues with the slope in this area since the slope is inaccessible with a drill rig.

The survey consisted of two seismic lines acquired at the site (Figure A-1), on March 8, 2023. The survey was performed by Collier Geophysicists Jorgen Bergstrom and Eric Armstrong. The following report presents results from the geophysical investigation and summarizes the site conditions, field methods, data acquisition, and interpretation procedures.

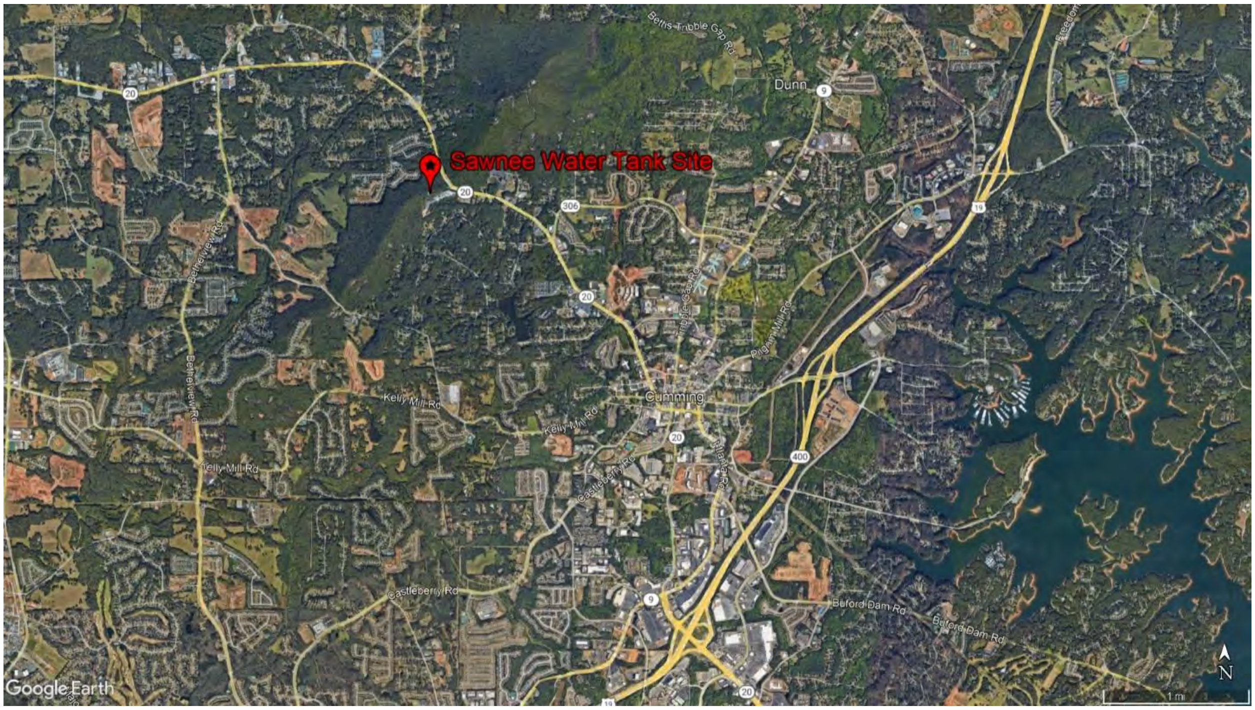


Figure 1: Approximate location of project site in Cumming, GA.
***Google Earth Imagery (2023)*.**

Site Description

The site consisted of steep terrain in a moderately dense forest. Asphalt waste was observed in the soil throughout the site. Weather conditions were mostly sunny and dry.

Data Acquisition

A total of two seismic lines were collected in the approximate locations originally requested by Client (Figure A-1). Profile 1 was approximately 200 feet in length while Profile 2 was approximately 300 feet in length. Each seismic line was collected using a twenty-four (24) 4.5 Hz geophones, with a sensor spacing of 10 feet. Seismic data were acquired using a Geometrics Geode 24-channel digital seismograph. This system utilizes a state-of-the-art, 24-bit seismograph connected to a field laptop via an Ethernet cable. Analog data from the geophones are collected in the seismograph where the data are digitized, transmitted to the laptop computer, and then recorded on the hard drive. The line locations and orientations were measured with an Emlid Reach RS2 GPS utilizing RTK corrections.

Seismic data were acquired using an active seismic source, consisting of a 16 lb sledgehammer impacting a plastic strike plate. Shot points were located every 10 feet along the line, beginning with a shot point located 5 feet off the end of the line. The first shot point of each line and every third shot along the line were collected with eight stacked records to improve signal-to-noise ratio for seismic refraction analysis. The remaining shot points were collected with two stacked records exclusively for MASW analysis. Acquisition was performed using 1 second records at a 0.125 millisecond (ms) sample rate.

Data Processing

Seismic Refraction Tomography (SRT)

Refraction data from this investigation were processed using Rayfract®, version 4.01, by Intelligent Resources Inc. The two steps involved with SRT processing are first arrival picking and tomographic inversion. The first arrival picking step consists of picking the time at which the first-arrival energy is observed at each signal trace for every shot record. **Figure 2** illustrates the picking approach used for SRT records, with an example from Profile 1 of this investigation. After picking is completed, an inversion is performed generating a two-dimensional (2D) Vp model that best fits the arrival picks by iteratively modifying an initial velocity gradient model until the misfit between the modeled and measured travel-time values is minimized, subject to smoothing constraints.

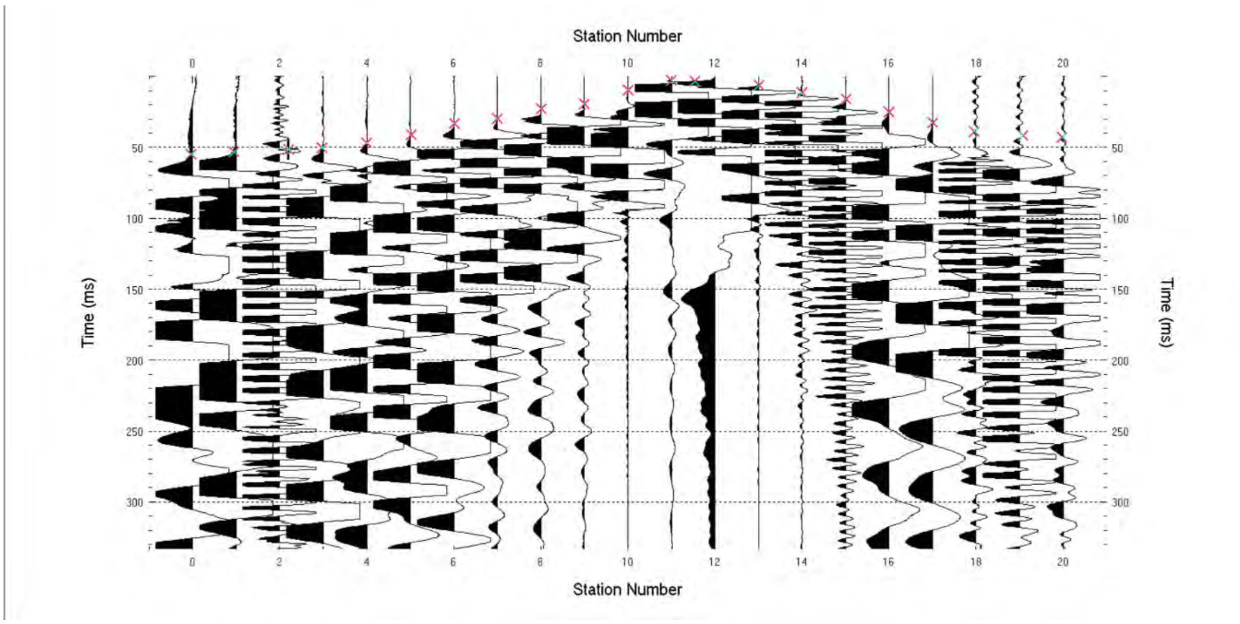


Figure 2: Example of the first-arrival picking (red Xs) on a sample refraction record from Profile 1.

Multi-channel Analysis of Surface Waves (MASW)

MASW analysis consists of generating a frequency-velocity transform from surface waves, picking the transformed data to derive dispersion curves and inverting dispersion curves to create layered Vs models. 1D Layered Vs models are generated for several subsets of the geophone spread, representing a bulk average Vs across each subset. These 1D models are positioned at the center of each subset and results are interpolated to generate a 2D Vs model across the profile. **Figure 3** illustrates the dispersion curve picking approach used for MASW soundings, with an example from this investigation. The program ParkSeis was used to accomplish these steps.

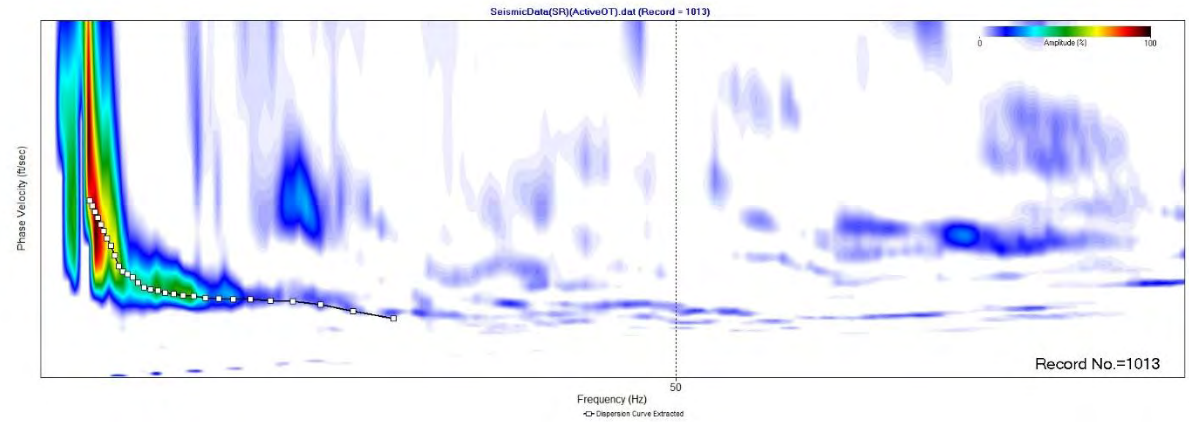


Figure 3: Example of dispersion curve picking (white squares) from Profile 1.

Results and Discussion

Seismic results are presented in **Figures A-2 and A-3**, appended to this report as 11x17 inch figures in landscape format. The figures each contain 2D Vp and Vs profiles. The Vp and Vs profiles are presented using consistent color scales between Profiles 1 and 2, with ‘cool’ colors (e.g. blue) representing lower velocity values and ‘warm’ colors (e.g., red) representing higher velocity values. Each of the profiles are presented at the same horizontal and vertical scale. Boring information provided by Client are plotted on each profile.

Based on limited boring information available along Profile 2 (**Figure A-3**), the top of partially-weathered rock (PWR) was interpreted in both profiles to correspond to approximately 4500 ft/s Vp and 800 ft/s Vs. Unweathered rock (UWR) was not documented in any boring data provided – UWR was interpreted to correspond to Vp values greater than approximately 6500 ft/s and Vs values greater than approximately 1200 ft/s which roughly correlates with auger refusal depth encountered in boring B-5 (**Figure A-3**). Without boring data confirming depth to UWR, interpretation of this horizon remains somewhat speculative.

The interpreted PWR surface generally follows surface topography along the profiles at approximately 20 feet below ground surface (BGS). The zone of weathered rock ranges from approximately 15 feet to 40 feet in thickness. PWR thickness is greatest at the ends of Profile 2 (**Figure A-3**) and at approximately 140 to 160 feet distance along Profile 1 (**Figure A-2**). The top of UWR surface also generally follows surface topography at approximately 40 to 50 feet BGS.

Vp and Vs of the overburden in Profile 1 (**Figure A-2**) appear to be reduced from approximately 30 to 140 feet distance along the profile. The Vp model shows significant heterogeneity in overburden velocity throughout the profile, lower velocity zones (blue) may suggest areas with less competent overburden. The Vs model shows a mostly continuous, approximately 10-foot thick band of reduced velocity material at approximately 30 feet BGS that may reflect a change in bedrock lithology or degree of weathering.

Vp of the overburden in Profile 2 (**Figure A-3**) also exhibits significant heterogeneity, lower-velocity zones are observed from approximately 0 – 80 feet, 105 – 130 feet, 135 – 175 feet, and 200 – 300 feet distance along the profile. Overburden Vs is slightly lower from 115 to 160 feet and 35 to 70 distance along the profile. Reduced velocity zones may indicate less competent overburden.

Closure

The quality of the seismic data acquired during this investigation was good for both methods.

The geophysical methods and field procedures defined in this report were applicable to the project objectives and have been successfully applied by Collier geophysicists to investigations of similar size and nature. However, sometimes field or subsurface conditions are different from those anticipated and the resultant data may not achieve the investigation objectives. Collier warrants that our services were performed within the limits prescribed for this project, with the usual thoroughness and competence of the geophysical profession. Collier conducted this project using the current standards of the geophysical industry and utilized in house quality control standards to produce a precise geophysical survey.

If you have any questions regarding the field procedures, data analyses, or the interpretive results presented herein, please do not hesitate to contact us. For further information regarding the details of MASW and SRT techniques, Collier can submit a more detailed description of the methods upon request. We appreciate working with you and look forward to providing Geosystems Engineering with geophysical services in the future.

Respectfully Submitted,

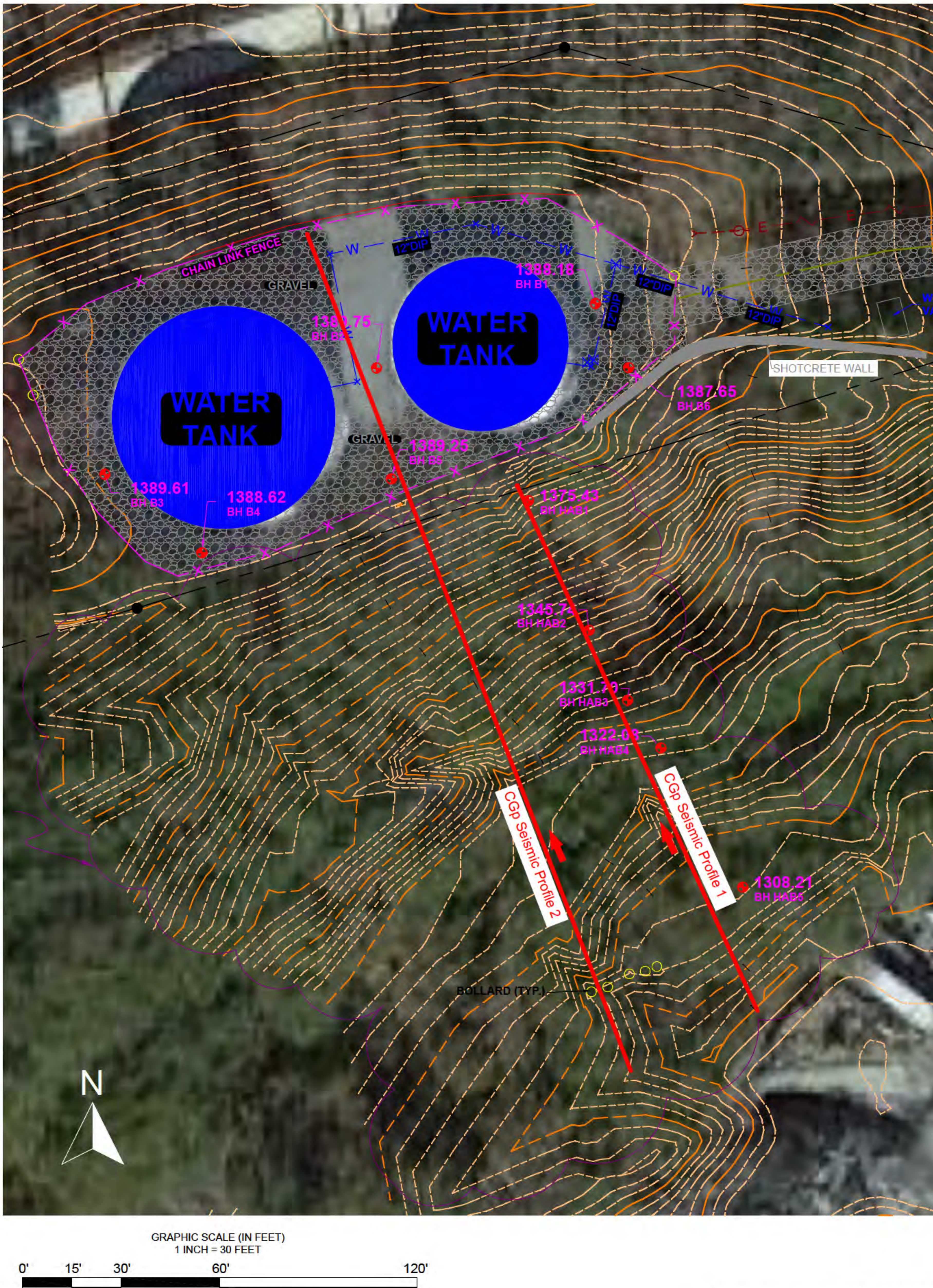
Collier Geophysics, LLC

Eric Armstrong
Geophysicist

Jorgen Bergstrom, P.G., P.Gp.
Senior Geophysicist

(1 copy e-mailed PDF format)

FIGURES



Seismic Profile Locations
Sawnee Tank Site
Cumming, Georgia

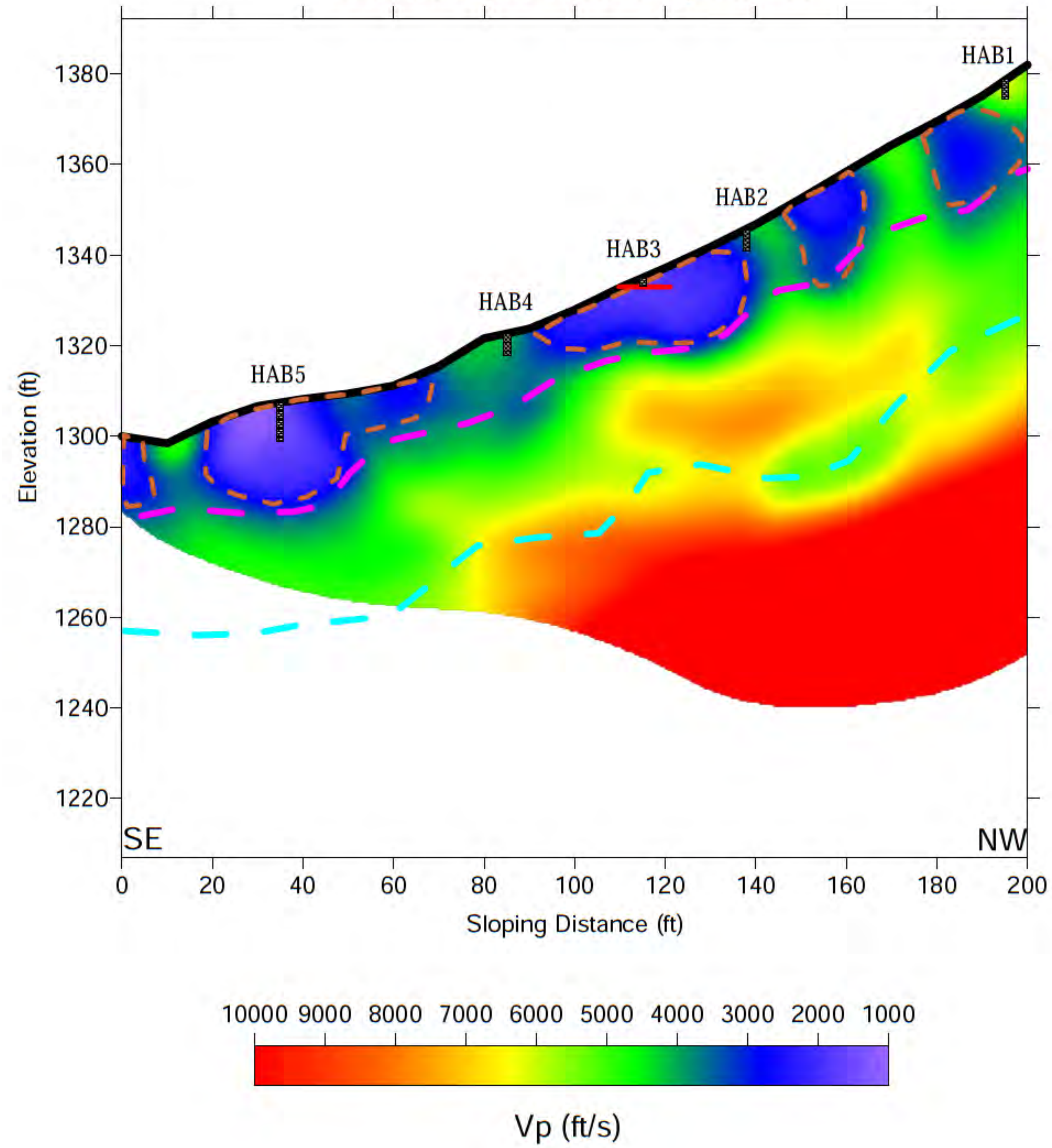
Geosystems Engineering

COLLIER GEOPHYSICS

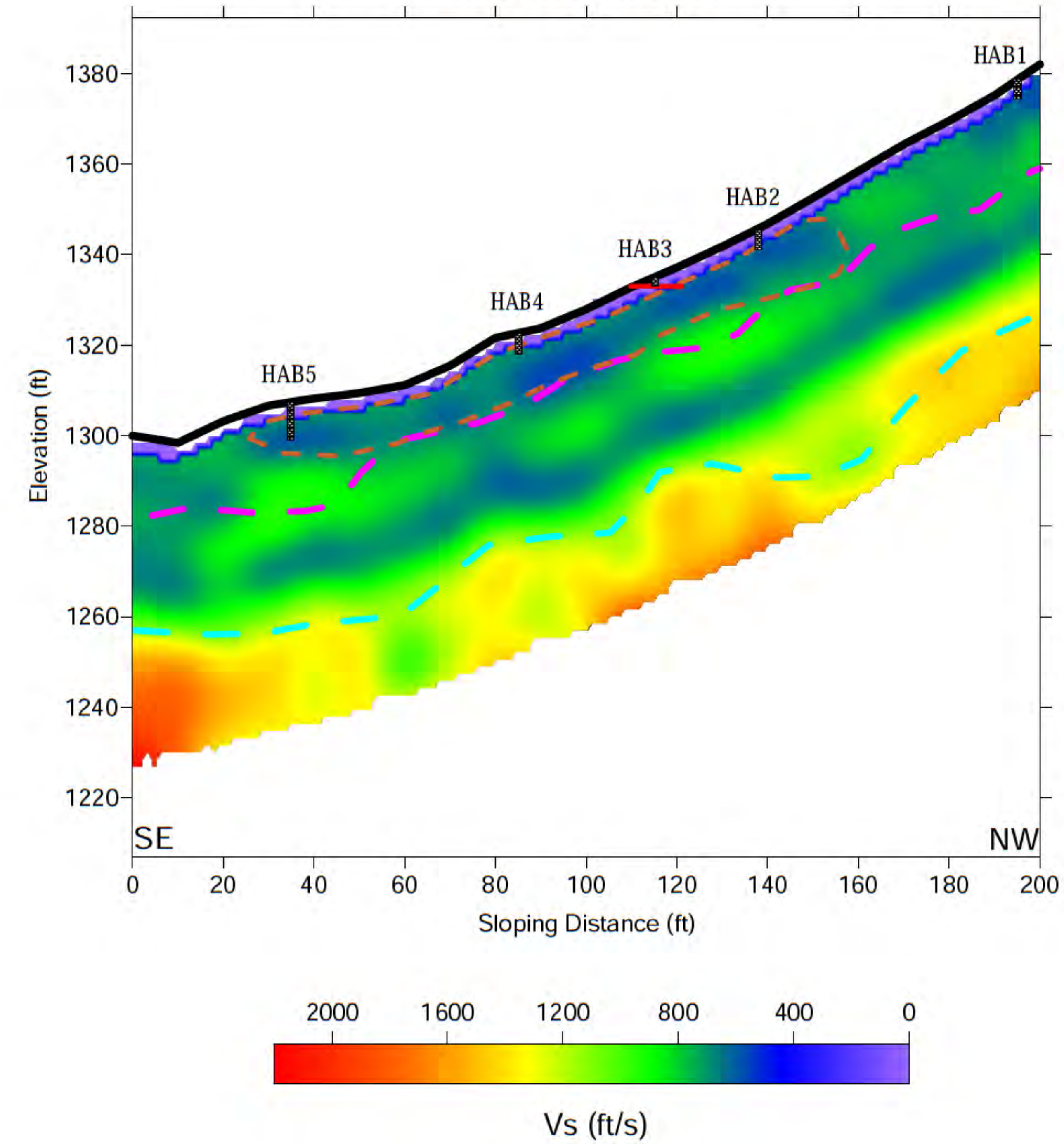
PROJECT #	FIGURE
230087	A-1

DRAFTED BY: EMA CHECKED BY: EJB March 2023

Profile 1
Seismic Refraction Vp Model



Profile 1
MASW Vs Model



LEGEND

Interpreted top of partially weathered rock (PWR)

Interpreted top of unweathered rock (UWR)

Interpreted Reduced-Velocity Zones

B-3 Boring ID

Overburden

PWR

UWR

Auger Refusal

Profile 1 SRT & MASW Models
Sawnee Water Tank Site
Cumming, Georgia

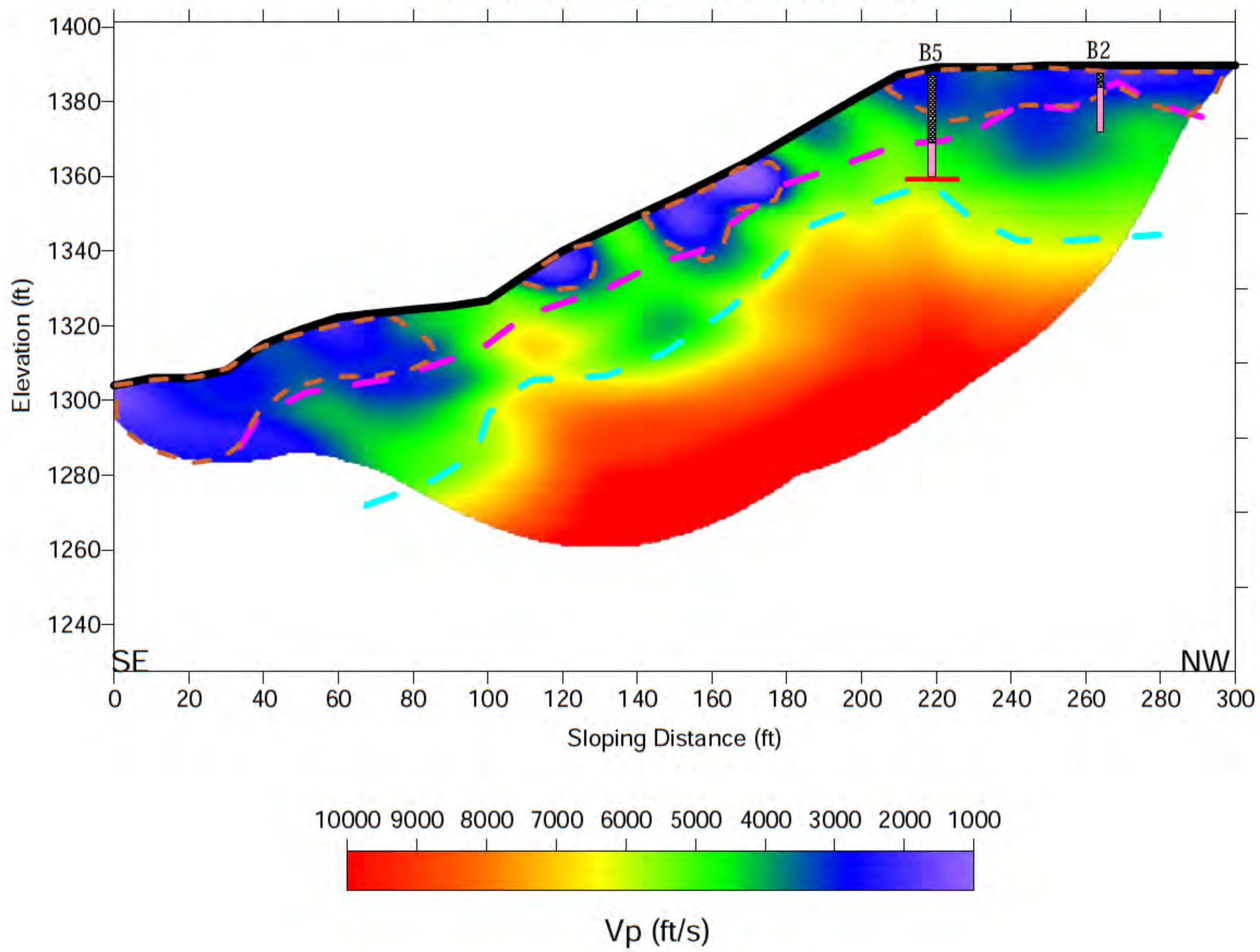
COLLIER GEOPHYSICS

Geosystems Engineering

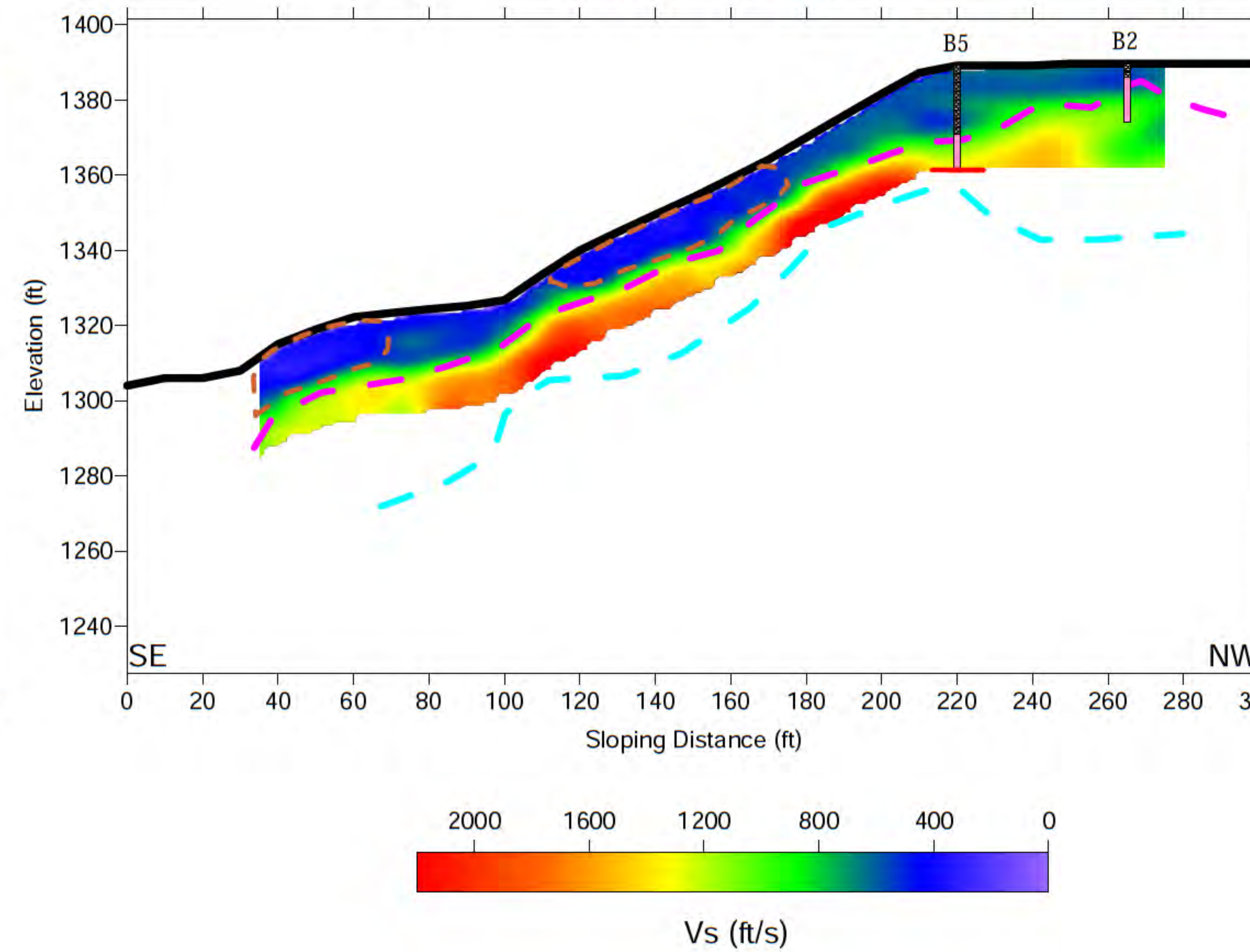
Project #: 230087 **FIGURE A-2**

Drafted by: E. Armstrong Checked by: J. Bergstrom March 2023

Profile 2
Seismic Refraction Vp Model



Profile 2
MASW Vs Model



LEGEND

Interpreted top of partially weathered rock (PWR)

Interpreted top of unweathered rock (UWR)

Interpreted Reduced-Velocity Zones

B-3 Boring ID

Overburden

PWR

UWR

Auger Refusal

Profile 2 SRT & MASW Models
Sawnee Water Tank Site
Cumming, Georgia

COLLIER GEOPHYSICS

Geosystems Engineering

Project #: 230087 **FIGURE A-3**

Drafted by: E. Armstrong Checked by: J. Bergstrom March 2023

APPEXDIX G

SLOPE STABILITY ANALYSIS REPORTS

```
===========================================================================
                 STABLPro for Windows, Version 2015.4.2

                         Upgraded from:
                         FHWA-PCSTABLE

                  Serial Number :  139303836

                     --Slope Stability Analysis--
                  Simplified Janbu, Simplified Bishop
                    or Spencer Method of Slices

===========================================================================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Roswell, GA

Path to file locations      : G:\GEI 2023\Geotechnical\Projects\22-2875 Cumming
                              Highway 20 Slope Failure\Stability Analysis\
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Name of output file         : CST-DD-1.sl4o
Name of plot output file    : CST-DD-1.sl4p

---------------------------------------------------------------------------
                     Time and Date of Analysis
---------------------------------------------------------------------------

          Date:  April 03, 2023     Time:  16:37:05



1
     PROBLEM DESCRIPTION   City of Cumming - Sawnee Tank Site
                           Profile D-D' Shallow Failure



     BOUNDARY COORDINATES

         9 Top   Boundaries
        19 Total Boundaries


     Boundary      X-Left      Y-Left     X-Right     Y-Right     Soil Type
```

No.	ft.	ft.	ft.	ft.	Below Bnd
1	50.00	96.00	100.00	96.00	2
2	100.00	96.00	105.00	100.00	1
3	105.00	100.00	117.00	100.00	1
4	117.00	100.00	153.00	110.00	1
5	153.00	110.00	168.00	120.00	1
6	168.00	120.00	215.00	140.00	1
7	215.00	140.00	285.00	188.00	1
8	285.00	188.00	287.00	189.00	2
9	287.00	189.00	362.00	189.00	2
10	100.00	96.00	153.00	100.00	1
11	153.00	100.00	168.00	110.00	2
12	168.00	110.00	215.00	130.00	2
13	215.00	130.00	270.00	172.00	2
14	270.00	172.00	285.00	188.00	2
15	50.00	76.00	100.00	76.00	3
16	100.00	76.00	168.00	92.00	3
17	168.00	92.00	215.00	120.00	3
18	215.00	120.00	285.00	151.00	3
19	285.00	151.00	362.00	151.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. pcf	Saturated Unit Wt. pcf	Cohesion Intercept psf	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant psf	Piez. Surface No.
1	115.0	120.0	0.0	25.0	0.00	0.0	1
2	115.0	120.0	0.0	34.0	0.00	0.0	1
3	125.0	130.0	0.0	45.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40 pcf

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water ft.	Y-Water ft.
1	50.00	76.00
2	100.00	76.00
3	168.00	92.00
4	215.00	110.00
5	285.00	140.00
6	362.00	140.00

1

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left ft.	X-Right ft.	Intensity psf	Deflection (deg)
1	295.00	350.00	2000.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 215.00 ft.
and X = 245.00 ft.

Each Surface Terminates Between X = 250.00 ft.
and X = 285.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y =130.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation.
The Angle Has Been Restricted Between The Angles Of -45.0
And 5.0 deg.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	245.00	160.57
2	246.99	160.72
3	248.97	161.03
4	250.91	161.51
5	252.81	162.14
6	254.65	162.92
7	256.42	163.85
8	258.11	164.93
9	259.70	166.14
10	261.19	167.48
11	262.56	168.93
12	263.81	170.49
13	264.93	172.15
14	265.90	173.90
15	266.58	175.37

Circle Center At X = 244.2 ; Y = 184.9 and Radius, 24.4

*** 0.817 ***

Individual data on the 14 slices

Slice No.	Width Ft	Weight Lbs	Water Force Top Lbs	Water Force Bot Lbs	Tie Force Norm Lbs	Tie Force Tan Lbs	Earthquake Force Hor Lbs	Earthquake Force Ver Lbs	Surcharge Load Lbs
1	2.0	0.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	2.0	0.40E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	1.9	0.60E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4	1.9	0.75E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	1.8	0.85E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6	1.8	0.90E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7	1.7	0.89E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8	1.6	0.84E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
9	1.5	0.75E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	1.4	0.62E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
11	1.2	0.48E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
12	1.1	0.33E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
13	1.0	0.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
14	0.7	0.39E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	238.33	156.00
2	240.33	156.13
3	242.30	156.47
4	244.23	157.01
5	246.08	157.76
6	247.85	158.70
7	249.50	159.82
8	251.03	161.11
9	252.42	162.55
10	253.64	164.13
11	254.69	165.83
12	255.55	167.64
13	255.63	167.86

Circle Center At X = 238.1 ; Y = 174.9 and Radius, 18.9

*** 0.829 ***

1

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	231.67	151.43
2	233.66	151.53
3	235.64	151.83
4	237.58	152.33
5	239.46	153.02
6	241.26	153.89
7	242.96	154.93
8	244.56	156.14
9	246.02	157.50
10	247.34	159.01
11	248.51	160.63
12	249.50	162.36
13	250.32	164.19
14	250.34	164.23

Circle Center At X = 231.6 ; Y = 171.5 and Radius, 20.1

*** 0.834 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	238.33	156.00
2	240.33	156.05
3	242.32	156.26
4	244.29	156.63
5	246.22	157.15
6	248.11	157.82
7	249.93	158.63
8	251.69	159.58
9	253.37	160.67
10	254.96	161.89
11	256.44	163.22
12	257.82	164.67
13	259.08	166.22
14	260.22	167.87
15	261.22	169.60
16	262.09	171.40
17	262.56	172.61

Circle Center At X = 238.6 ; Y = 181.5 and Radius, 25.5

*** 0.842 ***

1

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	218.33	142.29
2	220.33	142.38
3	222.32	142.58
4	224.30	142.87
5	226.26	143.26
6	228.20	143.75
7	230.12	144.33
8	232.00	145.00
9	233.85	145.77
10	235.66	146.62
11	237.42	147.56
12	239.14	148.59
13	240.80	149.70
14	242.41	150.89
15	243.95	152.16
16	245.44	153.50
17	246.85	154.91
18	248.20	156.39
19	249.47	157.94
20	250.66	159.54
21	251.78	161.20
22	252.81	162.92
23	253.75	164.68
24	254.61	166.49
25	255.00	167.43

Circle Center At X = 217.3 ; Y = 183.1 and Radius, 40.8

*** 0.848 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	241.67	158.29
2	243.66	158.40
3	245.61	158.85
4	247.46	159.63
5	249.14	160.71
6	250.62	162.05
7	251.85	163.63
8	252.79	165.40
9	253.01	166.06

Circle Center At X = 242.0 ; Y = 170.0 and Radius, 11.7

*** 0.853 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	235.00	153.71
2	237.00	153.75
3	238.98	154.00
4	240.93	154.47
5	242.81	155.14
6	244.61	156.01
7	246.30	157.08
8	247.87	158.32
9	249.30	159.72
10	250.56	161.28
11	251.64	162.96
12	252.54	164.74
13	253.04	166.09

Circle Center At X = 235.7 ; Y = 172.1 and Radius, 18.4

*** 0.857 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	235.00	153.71
2	237.00	153.64
3	239.00	153.73
4	240.98	153.99
5	242.93	154.43
6	244.84	155.02
7	246.69	155.78
8	248.47	156.69
9	250.17	157.75
10	251.77	158.95
11	253.26	160.28
12	254.64	161.73
13	255.88	163.30
14	256.99	164.96
15	257.95	166.72
16	258.76	168.54
17	259.41	170.44
18	259.42	170.46

Circle Center At X = 236.9 ; Y = 177.1 and Radius, 23.5

*** 0.882 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	238.33	156.00
2	240.33	155.97
3	242.32	156.22
4	244.25	156.76
5	246.08	157.56
6	247.78	158.61
7	249.31	159.89
8	250.65	161.38
9	251.76	163.04
10	252.62	164.85
11	253.01	166.06

Circle Center At X = 239.5 ; Y = 170.0 and Radius, 14.1

*** 0.888 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	235.00	153.71
2	237.00	153.61
3	239.00	153.68
4	240.98	153.95
5	242.93	154.39
6	244.83	155.02
7	246.66	155.82
8	248.41	156.78
9	250.07	157.91
10	251.61	159.18
11	253.02	160.60
12	254.30	162.13
13	255.43	163.78
14	256.40	165.53
15	257.21	167.36
16	257.84	169.26
17	257.87	169.40

Circle Center At X = 237.2 ; Y = 175.1 and Radius, 21.5

*** 0.896 ***

1

```
            Y         A     X     I     S          F     T

            0.00     45.25     90.50    135.75    181.00    226.25

X       0.00 +---------+---------+---------+---------+---------+
             -
             -
             -
             -
```

```
            -
      45.25 +
            -                *   *
            -
            -
            -
            -
A     90.50 +
            -                *   *
            -                     *
            -
            -                     *
            -
X    135.75 +
            -
            -                     * *
            -
            -                   *   *  *
            -
I    181.00 +
            -
            -
            -
            -
            -                       W  * * *5
S    226.25 +                             ..5.
            -                             ..533
            -                             ...521
            -                              ...521.
            -                              ....8118
            -                               .....111
     271.50 +                                 ....*..
            -                                   ......
            -                              W *     ...*
            -                                          /1
            -
            -
F    316.75 +
            -
            -
            -
            -                                          1/
            -
T    362.00 +                              W *        *
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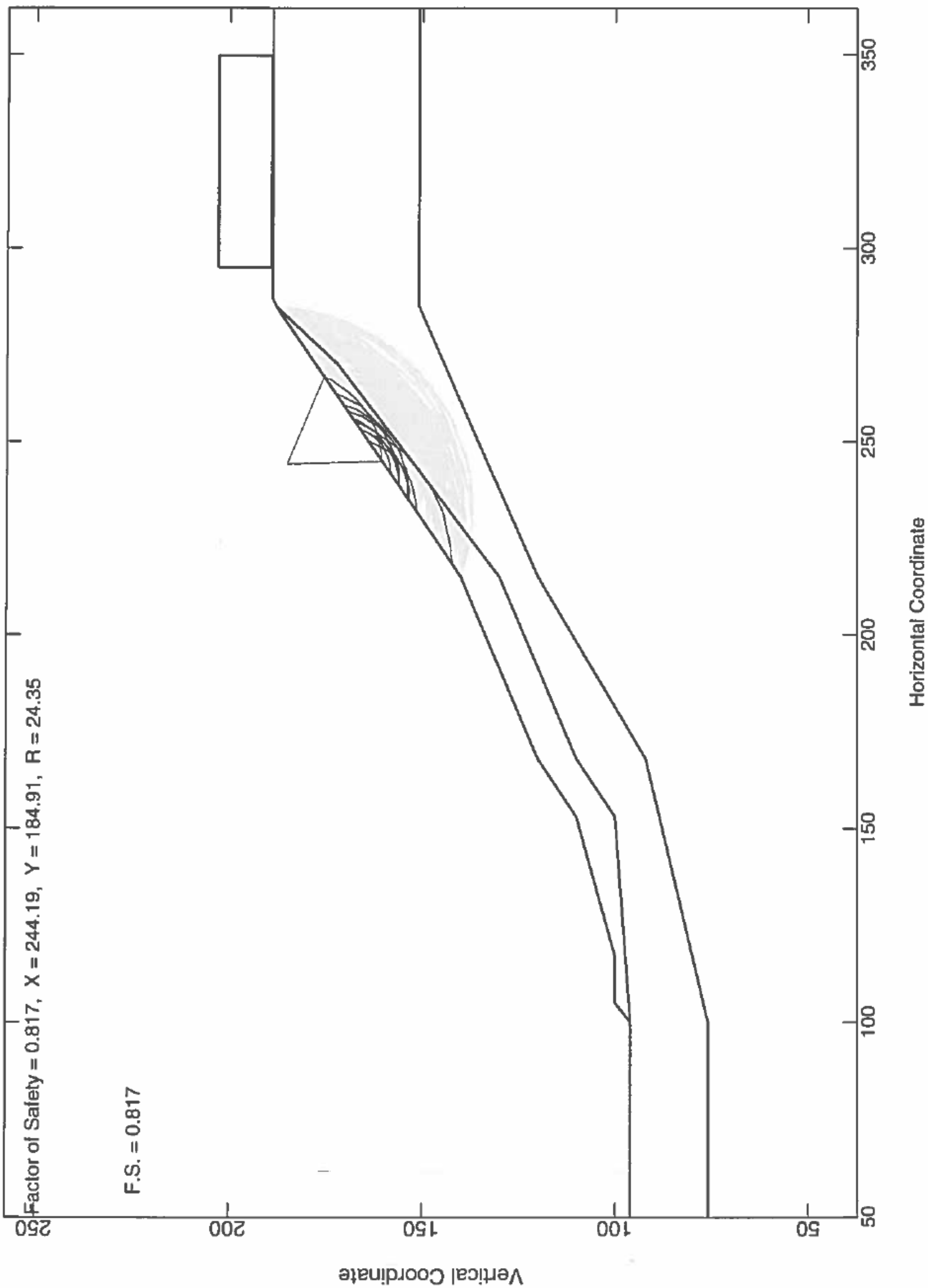
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Horizontal Coordinate
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150
200
250
300
350
50
100
150
200
250

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                 STABLPro for Windows, Version 2015.4.2

                         Upgraded from:
                         FHWA-PCSTABLE

                  Serial Number :  139303836

                    --Slope Stability Analysis--
                  Simplified Janbu, Simplified Bishop
                    or Spencer Method of Slices

=============================================================================


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Path to file locations       : G:\GEI 2023\Geotechnical\Projects\22-2875 Cumming
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Name of plot output file     : CST-DD-2.sl4p

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                     Time and Date of Analysis
-----------------------------------------------------------------------------

          Date:  April 03, 2023     Time:  17:40:29



1
     PROBLEM DESCRIPTION   City of Cumming - Sawnee Tank Site
                           Profile DD Shallow Failure



     BOUNDARY COORDINATES

         9 Top   Boundaries
        20 Total Boundaries


     Boundary     X-Left     Y-Left     X-Right     Y-Right     Soil Type
```

No.	ft.	ft.	ft.	ft.	Below Bnd
1	50.00	96.00	100.00	96.00	2
2	100.00	96.00	105.00	100.00	1
3	105.00	100.00	117.00	100.00	1
4	117.00	100.00	153.00	110.00	1
5	153.00	110.00	168.00	120.00	1
6	168.00	120.00	215.00	140.00	1
7	215.00	140.00	285.00	188.00	1
8	285.00	188.00	287.00	189.00	2
9	287.00	189.00	362.00	189.00	2
10	100.00	96.00	153.00	100.00	2
11	153.00	100.00	168.00	110.00	2
12	168.00	110.00	215.00	130.00	2
13	215.00	130.00	270.00	172.00	2
14	270.00	172.00	285.00	188.00	2
15	50.00	76.00	100.00	76.00	3
16	100.00	76.00	153.00	90.00	3
17	153.00	90.00	168.00	100.00	3
18	168.00	100.00	215.00	120.00	3
19	215.00	120.00	285.00	151.00	3
20	285.00	151.00	362.00	151.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. pcf	Saturated Unit Wt. pcf	Cohesion Intercept psf	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant psf	Piez. Surface No.
1	115.0	120.0	0.0	25.0	0.00	0.0	1
2	115.0	120.0	0.0	34.0	0.00	0.0	1
3	125.0	130.0	0.0	45.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40 pcf

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water ft.	Y-Water ft.
1	50.00	76.00
2	100.00	76.00
3	168.00	92.00
4	215.00	110.00
5	285.00	140.00
6	362.00	140.00

1

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left ft.	X-Right ft.	Intensity psf	Deflection (deg)
1	295.00	350.00	2000.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 210.00 ft.
and X = 250.00 ft.

Each Surface Terminates Between X = 285.00 ft.
and X = 325.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y =120.00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation.
The Angle Has Been Restricted Between The Angles Of -45.0
And 5.0 deg.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	239.47	156.78
2	241.47	156.95
3	243.45	157.19
4	245.43	157.50
5	247.39	157.87
6	249.35	158.31
7	251.28	158.81
8	253.20	159.38
9	255.09	160.02
10	256.97	160.71
11	258.82	161.48
12	260.64	162.30
13	262.43	163.18
14	264.20	164.13
15	265.93	165.13
16	267.62	166.20
17	269.28	167.32
18	270.90	168.49
19	272.48	169.72
20	274.01	171.00
21	275.50	172.33
22	276.95	173.72
23	278.34	175.15
24	279.69	176.62
25	280.99	178.15
26	282.23	179.71

27	283.42	181.32
28	284.56	182.97
29	285.64	184.65
30	286.66	186.37
31	287.62	188.12
32	288.07	189.00

Circle Center At X = 235.4 ; Y = 215.6 and Radius, 59.0

*** 1.085 ***

Individual data on the 35 slices

Slice No.	Width Ft	Weight Lbs	Water Force Top Lbs	Water Force Bot Lbs	Tie Force Norm Lbs	Tie Force Tan Lbs	Earthquake Force Hor Lbs	Earthquake Force Ver Lbs	Surcharge Load Lbs
1	2.0	0.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	2.0	0.40E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	2.0	0.65E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4	2.0	0.87E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	2.0	0.11E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6	1.9	0.13E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7	1.9	0.14E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8	0.5	0.39E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
9	1.4	0.12E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	1.9	0.17E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
11	1.8	0.18E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
12	1.8	0.18E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
13	1.8	0.19E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
14	1.8	0.19E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
15	1.7	0.19E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
16	1.7	0.19E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
17	1.7	0.19E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
18	0.7	0.82E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
19	0.9	0.10E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
20	1.6	0.18E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
21	1.5	0.17E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
22	1.5	0.16E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
23	1.4	0.15E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
24	1.4	0.14E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
25	1.3	0.12E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
26	1.3	0.11E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
27	1.2	0.97E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

28	1.2	0.82E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
29	1.1	0.67E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
30	0.4	0.23E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
31	0.6	0.29E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
32	1.0	0.36E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
33	0.3	0.87E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
34	0.6	0.10E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35	0.4	0.22E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	220.53	143.79
2	222.52	143.89
3	224.52	144.05
4	226.51	144.26
5	228.49	144.52
6	230.46	144.84
7	232.43	145.21
8	234.38	145.63
9	236.33	146.10
10	238.26	146.63
11	240.17	147.21
12	242.07	147.84
13	243.95	148.52
14	245.81	149.25
15	247.65	150.03
16	249.47	150.86
17	251.27	151.74
18	253.04	152.67
19	254.79	153.64
20	256.51	154.66
21	258.20	155.73
22	259.86	156.84
23	261.50	157.99
24	263.10	159.19
25	264.67	160.43
26	266.20	161.72
27	267.70	163.04
28	269.16	164.41
29	270.59	165.81
30	271.97	167.25
31	273.32	168.73
32	274.63	170.24
33	275.89	171.79
34	277.12	173.37

35	278.30	174.98
36	279.44	176.63
37	280.53	178.30
38	281.58	180.01
39	282.58	181.74
40	283.53	183.50
41	284.44	185.28
42	285.30	187.09
43	285.91	188.45

Circle Center At X = 217.7 ; Y = 218.1 and Radius, 74.4

*** 1.125 ***

1

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	222.63	145.23
2	224.63	145.39
3	226.62	145.60
4	228.60	145.84
5	230.58	146.13
6	232.55	146.47
7	234.51	146.85
8	236.47	147.27
9	238.41	147.74
10	240.35	148.25
11	242.27	148.81
12	244.18	149.40
13	246.07	150.04
14	247.95	150.72
15	249.82	151.45
16	251.67	152.21
17	253.50	153.02
18	255.31	153.86
19	257.10	154.75
20	258.87	155.68
21	260.63	156.64
22	262.35	157.65
23	264.06	158.69
24	265.74	159.77
25	267.40	160.89
26	269.03	162.04

27	270.64	163.24
28	272.22	164.46
29	273.77	165.72
30	275.29	167.02
31	276.79	168.35
32	278.25	169.71
33	279.68	171.11
34	281.09	172.54
35	282.45	173.99
36	283.79	175.48
37	285.09	177.00
38	286.36	178.55
39	287.60	180.12
40	288.79	181.72
41	289.95	183.35
42	291.08	185.00
43	292.17	186.68
44	293.22	188.38
45	293.58	189.00

Circle Center At X = 216.5 ; Y = 234.5 and Radius, 89.5

*** 1.146 ***

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	224.74	146.68
2	226.74	146.77
3	228.73	146.90
4	230.72	147.08
5	232.71	147.31
6	234.69	147.57
7	236.67	147.88
8	238.64	148.23
9	240.60	148.63
10	242.55	149.07
11	244.49	149.55
12	246.42	150.07
13	248.34	150.64
14	250.24	151.25
15	252.13	151.90
16	254.01	152.59
17	255.87	153.32

18	257.72	154.10
19	259.54	154.91
20	261.35	155.76
21	263.14	156.65
22	264.91	157.59
23	266.66	158.56
24	268.39	159.57
25	270.09	160.61
26	271.77	161.69
27	273.43	162.81
28	275.06	163.97
29	276.67	165.16
30	278.25	166.39
31	279.80	167.65
32	281.33	168.94
33	282.82	170.27
34	284.29	171.63
35	285.72	173.02
36	287.13	174.45
37	288.50	175.90
38	289.85	177.38
39	291.15	178.90
40	292.43	180.44
41	293.67	182.01
42	294.88	183.60
43	296.05	185.22
44	297.18	186.87
45	298.28	188.54
46	298.57	189.00

Circle Center At X = 221.6 ; Y = 237.8 and Radius, 91.1

*** 1.165 ***

1

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	243.68	159.67
2	245.68	159.65
3	247.68	159.71
4	249.68	159.85
5	251.67	160.08
6	253.64	160.38

7	255.61	160.77
8	257.55	161.23
9	259.47	161.78
10	261.38	162.40
11	263.25	163.10
12	265.09	163.88
13	266.90	164.73
14	268.68	165.65
15	270.41	166.65
16	272.10	167.71
17	273.75	168.85
18	275.35	170.05
19	276.90	171.31
20	278.39	172.64
21	279.83	174.03
22	281.22	175.47
23	282.54	176.97
24	283.80	178.53
25	284.99	180.13
26	286.12	181.78
27	287.18	183.48
28	288.17	185.22
29	289.09	186.99
30	289.94	188.81
31	290.02	189.00

Circle Center At X = 245.2 ; Y = 208.5 and Radius, 48.9

*** 1.190 ***

Failure Surface Specified By 52 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	210.00	137.87
2	212.00	137.80
3	214.00	137.77
4	216.00	137.80
5	218.00	137.87
6	219.99	137.99
7	221.99	138.16
8	223.97	138.37
9	225.96	138.64
10	227.93	138.95
11	229.90	139.31

12	231.86	139.72
13	233.80	140.18
14	235.74	140.68
15	237.66	141.23
16	239.57	141.83
17	241.47	142.47
18	243.34	143.16
19	245.20	143.90
20	247.04	144.68
21	248.87	145.50
22	250.67	146.37
23	252.45	147.28
24	254.21	148.24
25	255.94	149.23
26	257.65	150.27
27	259.33	151.35
28	260.99	152.47
29	262.62	153.63
30	264.22	154.83
31	265.79	156.07
32	267.33	157.35
33	268.84	158.66
34	270.31	160.01
35	271.76	161.39
36	273.17	162.81
37	274.54	164.27
38	275.88	165.75
39	277.18	167.27
40	278.45	168.82
41	279.67	170.40
42	280.86	172.01
43	282.01	173.65
44	283.12	175.31
45	284.18	177.00
46	285.21	178.72
47	286.19	180.46
48	287.14	182.22
49	288.03	184.01
50	288.89	185.82
51	289.70	187.65
52	290.26	189.00

Circle Center At X = 214.0 ; Y = 220.1 and Radius, 82.3

*** 1.202 ***

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	228.95	149.56
2	230.95	149.49
3	232.95	149.48
4	234.95	149.55
5	236.94	149.68
6	238.93	149.88
7	240.91	150.15
8	242.88	150.49
9	244.84	150.90
10	246.78	151.37
11	248.71	151.91
12	250.62	152.52
13	252.50	153.19
14	254.36	153.93
15	256.19	154.73
16	257.99	155.60
17	259.77	156.52
18	261.51	157.51
19	263.21	158.56
20	264.88	159.66
21	266.51	160.82
22	268.09	162.04
23	269.64	163.31
24	271.14	164.63
25	272.59	166.01
26	273.99	167.43
27	275.35	168.90
28	276.65	170.42
29	277.90	171.98
30	279.10	173.59
31	280.23	175.23
32	281.31	176.92
33	282.34	178.63
34	283.30	180.39
35	284.20	182.17
36	285.04	183.99
37	285.81	185.83
38	286.52	187.70
39	286.96	188.98

Circle Center At X = 232.1 ; Y = 207.3 and Radius, 57.9

*** 1.203 ***

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	243.68	159.67
2	245.68	159.59
3	247.68	159.60
4	249.68	159.70
5	251.67	159.88
6	253.66	160.15
7	255.62	160.50
8	257.58	160.93
9	259.51	161.45
10	261.42	162.05
11	263.30	162.73
12	265.15	163.49
13	266.96	164.33
14	268.74	165.24
15	270.48	166.23
16	272.17	167.29
17	273.82	168.43
18	275.42	169.63
19	276.96	170.90
20	278.45	172.24
21	279.88	173.64
22	281.25	175.10
23	282.55	176.61
24	283.79	178.18
25	284.97	179.80
26	286.07	181.47
27	287.10	183.19
28	288.05	184.94
29	288.93	186.74
30	289.73	188.57
31	289.89	189.00

Circle Center At X = 246.4 ; Y = 206.4 and Radius, 46.8

*** 1.215 ***

1

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	250.00	164.00
2	252.00	163.85
3	253.99	163.82
4	255.99	163.91
5	257.98	164.12
6	259.95	164.45
7	261.90	164.90
8	263.82	165.46
9	265.71	166.14
10	267.54	166.93
11	269.33	167.82
12	271.06	168.82
13	272.73	169.93
14	274.33	171.13
15	275.86	172.42
16	277.30	173.80
17	278.66	175.27
18	279.93	176.82
19	281.10	178.44
20	282.18	180.12
21	283.15	181.87
22	284.02	183.67
23	284.77	185.52
24	285.42	187.42
25	285.67	188.34

Circle Center At X = 253.5 ; Y = 197.2 and Radius, 33.4

*** 1.217 ***

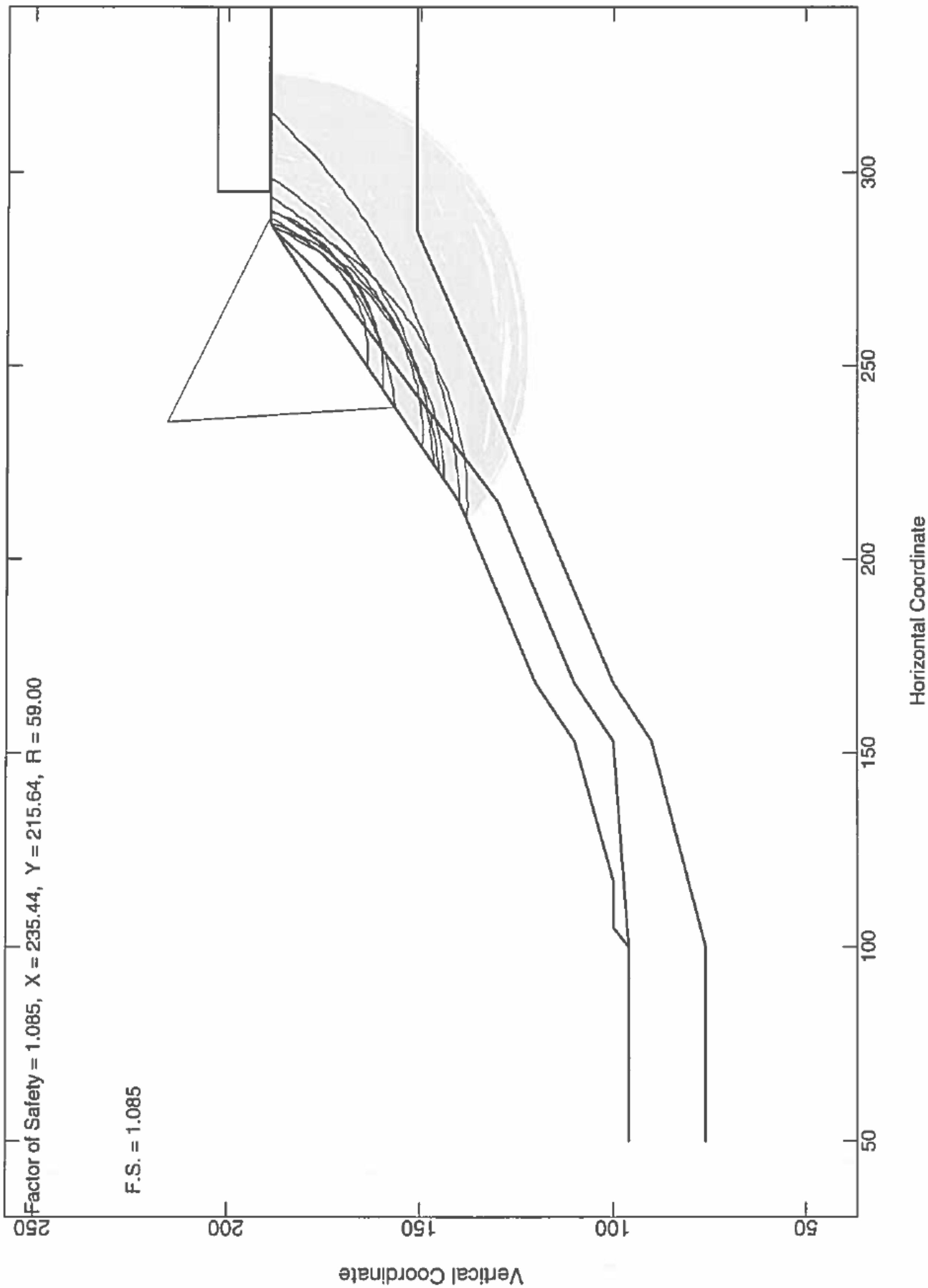
Failure Surface Specified By 59 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.
1	214.21	139.66
2	216.21	139.80
3	218.20	139.96
4	220.19	140.14
5	222.18	140.36
6	224.17	140.60

7	226.15	140.86
8	228.13	141.16
9	230.10	141.48
10	232.07	141.83
11	234.03	142.21
12	235.99	142.61
13	237.95	143.04
14	239.89	143.50
15	241.83	143.98
16	243.77	144.49
17	245.69	145.03
18	247.61	145.59
19	249.52	146.18
20	251.43	146.79
21	253.32	147.44
22	255.21	148.10
23	257.08	148.79
24	258.95	149.51
25	260.81	150.26
26	262.65	151.03
27	264.49	151.82
28	266.31	152.64
29	268.12	153.49
30	269.93	154.36
31	271.71	155.25
32	273.49	156.17
33	275.26	157.11
34	277.01	158.08
35	278.74	159.07
36	280.47	160.08
37	282.18	161.12
38	283.87	162.18
39	285.55	163.27
40	287.22	164.37
41	288.87	165.50
42	290.50	166.66
43	292.12	167.83
44	293.72	169.03
45	295.31	170.25
46	296.88	171.49
47	298.43	172.75
48	299.96	174.03
49	301.48	175.34
50	302.98	176.66
51	304.46	178.01
52	305.92	179.37
53	307.36	180.76
54	308.79	182.16
55	310.19	183.59
56	311.58	185.03

```
   57          312.94      186.49
   58          314.28      187.97
   59          315.19      189.00

Circle Center At X =  205.6 ; Y =  285.3  and Radius,  145.9


      ***     1.241    ***



1

           Y            A     X     I     S            F     T


           0.00     45.25     90.50    135.75    181.00    226.25

X      0.00 +---------+---------+---------+---------+---------+
            -
            -
            -
            -
            -
      45.25 +
            -                *   *
            -
            -
            -
            -
A     90.50 +
            -                *   *
            -                     *
            -
            -                     *
            -
X    135.75 +
            -
            -                   * * *
            -
            -                   W * *  *
            -
I    181.00 +
            -
            -
            -
            -                             60
            -                       W  * *6*2
S    226.25 +                           ...627
            -                           ...623.
```

```
          -          ....622.1
          -          .....62219
          -          ......6211
          -          ......04211
   271.50 +          .......0421*
          -           .......043111
          -           ...W.*..004311*
          -            ........00.433/1
          -             ........00..4
          -               ........00.
F  316.75 +                 ........0
          -                    ......
          -
          -
          -                          1/
          -
T  362.00 +              W *        *
```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F.S. = 1.085
Vertical Coordinate
Horizontal Coordinate
250
200
150
100
50
50
100
150
200
250
300

```
===========================================================================

                 STABLPro for Windows, Version 2015.4.2

                         Upgraded from:
                         FHWA-PCSTABLE

                  Serial Number :  139303836

                     --Slope Stability Analysis--
                  Simplified Janbu, Simplified Bishop
                    or Spencer Method of Slices

===========================================================================


This program is licensed to :

Geosystems Engineering, Inc.
Roswell, GA

Path to file locations       : G:\GEI 2023\Geotechnical\Projects\22-2875 Cumming
                               Highway 20 Slope Failure\Stability Analysis\
Name of input data file      : CST-DD-5.sl4d
Name of output file          : CST-DD-5.sl4o
Name of plot output file     : CST-DD-5.sl4p

---------------------------------------------------------------------------
                     Time and Date of Analysis
---------------------------------------------------------------------------

          Date:  April 03, 2023     Time:  18:02:50



1
     PROBLEM DESCRIPTION   City of Cumming - Sawnee Tank Site
                           Profile D-D' Translational Slide



     BOUNDARY COORDINATES

         9 Top    Boundaries
        20 Total Boundaries


     Boundary     X-Left     Y-Left     X-Right     Y-Right     Soil Type
```

No.	ft.	ft.	ft.	ft.	Below Bnd
1	50.00	96.00	100.00	96.00	2
2	100.00	96.00	105.00	100.00	1
3	105.00	100.00	117.00	100.00	1
4	117.00	100.00	153.00	110.00	1
5	153.00	110.00	168.00	120.00	1
6	168.00	120.00	215.00	140.00	1
7	215.00	140.00	285.00	188.00	1
8	285.00	188.00	287.00	189.00	2
9	287.00	189.00	362.00	189.00	2
10	100.00	96.00	153.00	100.00	2
11	153.00	100.00	168.00	110.00	2
12	168.00	110.00	215.00	130.00	2
13	215.00	130.00	270.00	172.00	2
14	270.00	172.00	285.00	188.00	2
15	50.00	76.00	100.00	76.00	3
16	100.00	76.00	153.00	90.00	1
17	153.00	90.00	168.00	100.00	3
18	168.00	100.00	215.00	120.00	3
19	215.00	120.00	285.00	151.00	3
20	285.00	151.00	362.00	151.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. pcf	Saturated Unit Wt. pcf	Cohesion Intercept psf	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant psf	Piez. Surface No.
1	115.0	120.0	0.0	25.0	0.00	0.0	1
2	115.0	120.0	0.0	34.0	0.00	0.0	1
3	125.0	130.0	0.0	45.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40 pcf

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water ft.	Y-Water ft.
1	50.00	76.00
2	100.00	76.00
3	168.00	92.00
4	215.00	110.00
5	285.00	140.00
6	362.00	140.00

1

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left ft.	X-Right ft.	Intensity psf	Deflection (deg)
1	295.00	350.00	2000.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

1

Searching Routine Will Be Limited To An Area Defined By 5 Boundaries
Of Which The First 5 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left ft.	Y-Left ft.	X-Right ft.	Y-Right ft.
1	50.00	76.00	100.00	76.00
2	100.00	76.00	168.00	92.00
3	168.00	92.00	215.00	120.00
4	215.00	120.00	285.00	151.00
5	285.00	151.00	335.00	189.00

1

Trial Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf ft.	Y-Surf ft.

1	100.00	96.00
2	153.00	100.00
3	168.00	110.00
4	215.00	130.00
5	270.00	172.00
6	285.00	188.00

Factor Of Safety For The Preceding Specified Surface = 0.975

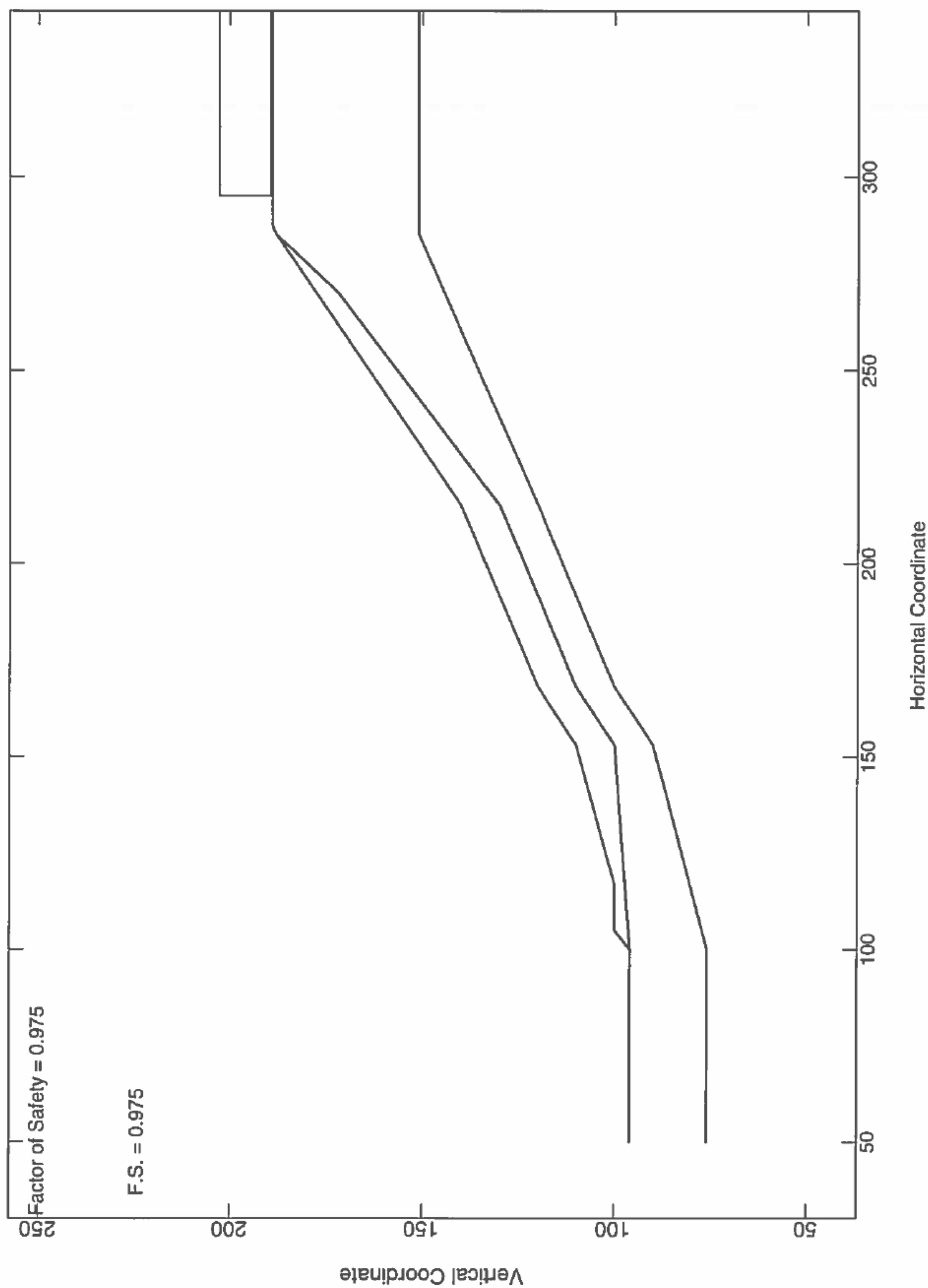
1

```
           Y            A     X     I     S            F     T

           0.00     45.25     90.50    135.75    181.00    226.25

X      0.00 +---------+---------+---------+---------+---------+
            -
            -
            -
            -
            -
      45.25 +
            -                *   *
            -
            -
            -
            -
A     90.50 +
            -                *   *
            -                     *
            -
            -                     *
            -
X    135.75 +
            -
            -                   * * *
            -
            -                   L * *  *
            -
I    181.00 +
            -
            -
            -
            -
            -                       W  * * *
S    226.25 +
```

```
            -
            -
            -
            -
            -
     271.50 +                                      *
            -
            -                               W *        *
            -                                           /1
            -
            -
F    316.75 +
            -
            -                                          L
            -
            -                                           1/
            -
T    362.00 +                               W *        *
```


Factor of Safety = 0.975
F.S. = 0.975
Horizontal Coordinate
50
100
150
200
250
300
Vertical Coordinate
50
100
150
200
250